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THE JOURNAL OF THE SOCIETY OF AUTOMOTIVE ENGINEERS

S·A·E

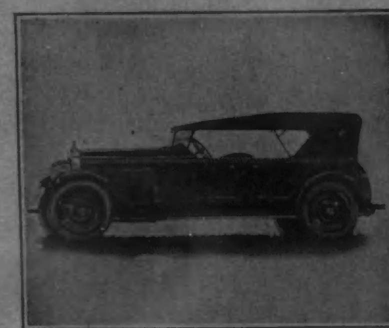
NOVEMBER 1923

PRODUCTION MEETING NUMBER

SOCIETY OF AUTOMOTIVE ENGINEERS INC.
29 WEST 39TH STREET NEW YORK

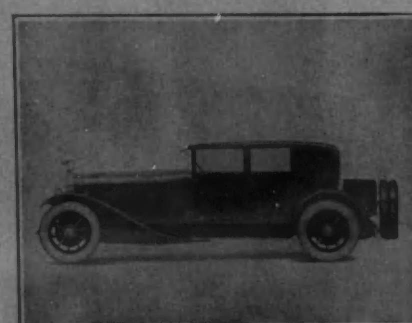
The kind of cars that use them

FRANKLIN



PACKARD
Single Eight

DUESENBERG
"STRAIGHT 8"



ISOTTA FRASCHINI
Eight in Line

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THE
JOURNAL
OF THE SOCIETY OF
AUTOMOTIVE ENGINEERS

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H. W. ALDEN, *President* COKER F. CLARKSON, *Secretary* C. B. WHITTELSEY, *Treasurer*

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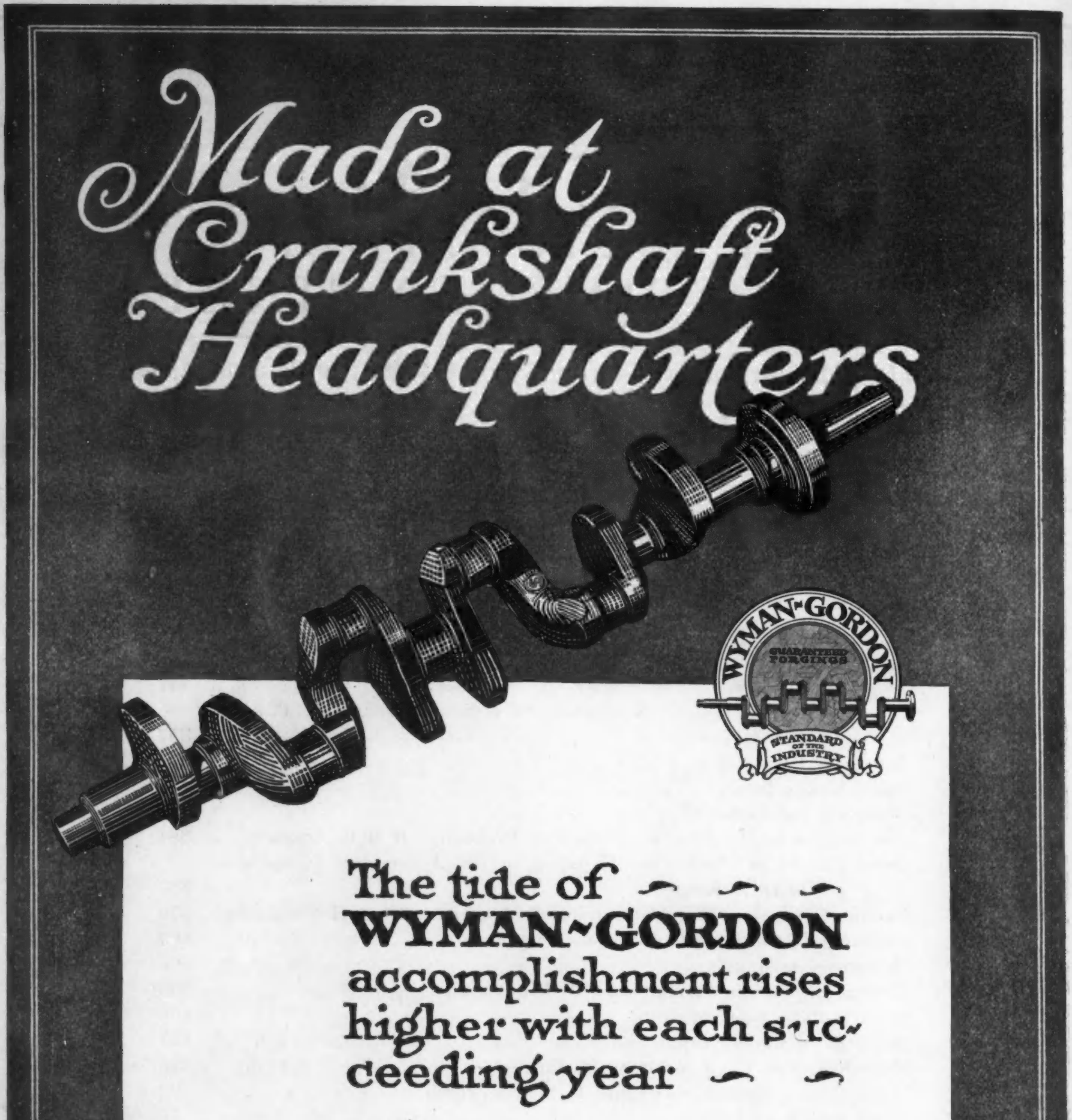
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THE JOURNAL OF THE SOCIETY OF AUTOMOTIVE ENGINEERS

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Chronicle and Comment

The Production Meeting

MOST of the papers read at the second national Production Meeting of the Society are printed in full in this issue of THE JOURNAL. Illustrated reports of the four sessions and Production Dinner held in Cleveland Oct. 25 and 26 will be found commencing on p. 429. To say that the meeting was enthusiastically received, is putting it mildly. The attendance of production executives in gratifying numbers served as further evidence that this phase of the Society's work is appreciated.

The Production Meeting is now an established institution and will be included permanently in the meetings activities of the parent Society. In addition, several of the Sections are devoting a part of their meetings to production matters. The Detroit Section has announced the scheduling of two monthly meetings in the future, one of which will treat manufacturing problems exclusively. Thus we proceed to the inevitable ideal of true cooperation between the designer and the constructor.

Automotive Standardization

ALTHOUGH the Society's Standards Committee is the recognized standardizing body in the automotive industry, its work is supplemented and strengthened by other organizations having a national status. Briefly, these organizations and their objects are

(1) American Engineering Standards Committee, a national clearing-house for standards

(2) Division of Simplified Practice, a division of the Department of Commerce organized by Secretary Hoover to aid in reducing standards to practice

(3) Automotive Simplified Practice Committee, a committee representative of automotive associations organized at the request of the Division of Simplified Practice, its object being to encourage the adoption of automotive standards in future production

In addition to these, there are a large number of technical societies and trade associations having a limited scope within the automotive industry with which the Standards Committee, through its Divisions, is actively cooperating.

Maintenance Problems

AN invitation has been extended to our members by the National Automobile Chamber of Commerce to participate in its Service Managers Convention at Dayton, Ohio, Nov. 20 and 21. Meetings devoted to topics that are of equal interest to the designer and the service-man will be held in the morning and afternoon of both days. Papers on the following subjects will be read and discussed: evils of head-lamp dimming; instructions on head-lamp adjustment; engineering lessons taught by the flat-rate system; educating the public to combat the evils of crankcase dilution.

One session will include a discussion of what the engineer can do to simplify electrical repairs. Designing cars to eliminate the need of costly special tools for making repairs will be another important topic. These meetings present an excellent opportunity for the engineer to learn what troubles are encountered generally in the maintenance of motor vehicles. Thus he will be enabled to combat them with improvements that can be incorporated in future designs.

Non-Member Affiliation with Sections

THE Governing Committees of the Cleveland, Detroit, Metropolitan and Washington Sections of the Society have gone on record as being favorable to the establishment of some form of local Section membership that will be open to men who are not members of the Society. Such local Section members would have no privileges in the parent Society and would not receive its publications; they would merely be entitled to the privilege of attending the meetings of the Section with which they became affiliated.

In this connection, a resolution approved by the members present at the October meeting of the Metropolitan Section is representative of the plan being agitated.

> WHEREAS, it will be of advantage to the Metropolitan Section to take in Section members to be known as Associates, these men not being members of the Society, but nevertheless men who may greatly profit by the contact and association with the Metropolitan Section, and whose experience and discussion may correspondingly be of benefit to the Metropolitan Section, be it

Resolved, that it is advisable to have the active participation and financial support of the large number of men in this district who either are not eligible as regular members or who could not reasonably be expected to become members of the Society to join the Section, and that the Council of the Society of Automotive Engineers is hereby requested to authorize suitable Associate Section membership at $5 per annum.

To become operative, this form of participation in local meetings must receive the approval of the Council of the Society before it can be incorporated in the Constitution and By-Laws of the Sections.

Combined Society and Sections Dues

CONSIDERABLE discussion has been had among various members of the Society who are connected with the work of the Sections, on several points raised with regard to the methods that will result in the most satisfactory and valuable Sections activities. As some amendments to the Constitution of the Society may be proposed at the Business Session of the Annual Meeting to be held in January, attention is called here to a resolution that originated in the Metropolitan Section, so that the members can have an opportunity to study in advance the questions involved. The resolution, as approved by the members of the Metropolitan Section present at the October meeting of that Section, is as follows:

WHEREAS, the main activities of the Society of Automotive Engineers are being carried on by its Sections, and the Section Officers are already burdened with all the detail they can reasonably be asked to carry, and

WHEREAS, larger funds are necessary to carry on the Section activities properly, and these should be raised from among those Society of Automotive Engineers members who directly or indirectly enjoy the results of the Section activities, therefore be it

Resolved, that it is advisable to increase the annual dues of all but Student members of the Society from $15 to $20; that the increase of $5 includes a Section membership, and that this sum be credited to the Section in which the individual resides or makes his business headquarters. Further, that the dues for a Society member residing and having his place of business more than 30 miles from the city in which the Section has its headquarters, be $15, unless such Society member desires to become a Section member.

The dues of members of the Society are, of course, specified by its Constitution and cannot be changed except by proper amendment of that document. At the present time the annual dues for all grades of Society members are $15, except in the case of Service, Foreign and Junior members whose annual dues are $10.

Motor Vehicle Speeds

AS to the technical questions involved in speed limits for motor vehicles, it is believed that the recommendations of the Joint Committee on Uniform Vehicle Laws can safely be adopted. The speed limits are as given in the next column.

The recommendations of the committee are based on a careful survey of the existing traffic regulations throughout the Country, considered in the light of present technical knowledge. The speeds recommended are, of course, intended to be actual limiting speeds under the existing traffic conditions specified, namely, open road, suburban streets, and urban streets, and it is assumed that the law will be strictly enforced. There is no question that these speeds are *perfectly safe* for vehicles which are in proper mechanical condition, driven on roads which are suitably surfaced and dry. To actually enforce speed-limits slower than this would work an economic injustice not so much on the user of motor vehicles as on the whole community, since the ultimate cost is always paid by the consumer. Maximum safe speed is the essence of highway transport economy, and vehicles are constantly being developed toward increasing their safe speeds.

Maximum Weight, Including Gross Weight of Vehicle and Load	Open Country Highway	Suburban Street	Urban Street
VEHICLES DESIGNED FOR CARRYING NOT MORE THAN SEVEN PASSENGERS			
6,000 lb.	30 miles	20 miles	15 miles
OTHER VEHICLES EQUIPPED WITH PNEUMATIC TIRES			
6,000 lb.	25 miles	20 miles	15 miles
8,000 lb.	25 miles	20 miles	15 miles
12,000 lb.	25 miles	20 miles	15 miles
16,000 lb.	25 miles	20 miles	15 miles
20,000 lb.	25 miles	20 miles	15 miles
24,000 lb.	25 miles	20 miles	15 miles
28,000 lb.	25 miles	20 miles	15 miles
VEHICLES EQUIPPED WITH SOLID TIRES			
4,000 lb.	25 miles	20 miles	15 miles
8,000 lb.	20 miles	18 miles	12 miles
12,000 lb.	18 miles	15 miles	12 miles
16,000 lb.	16 miles	15 miles	12 miles
20,000 lb.	15 miles	15 miles	12 miles
24,000 lb.	15 miles	15 miles	12 miles
28,000 lb.	15 miles	15 miles	12 miles

In the last analysis, enforcement of any regulation of this kind depends upon its reasonableness. If the average conservative driver does not consider the regulation reasonable, no practicable amount of policing will serve to enforce it, particularly if it interferes with business.

There is a phase of the safety problem which is much more serious than the regulation of maximum speeds. This is regulation of the speeds at which vehicles are usually operated when the traffic and other conditions require special caution. Some of these conditions are:

(1) Roads wet or covered with ice or snow
(2) Hidden crossings or corners with bad visibility
(3) Vehicles with defective or inadequate brakes
(4) Vehicles overloaded beyond their capacity

Safety depends almost entirely on the ability of the driver to stop within the clear space available. No speed is safe unless the driver can be sure that he has enough clear road ahead in which to stop before anything can get in his way. At 25 m.p.h. a vehicle fitted with pneumatic tires and suitable brakes, and operating on a dry road, can be stopped in from 50 to 75 ft. If the road is wet or icy, the distance required may be three or four times as great. A speed of 15 m.p.h. on the wet road is probably more dangerous than 20 m.p.h. on the dry road.

Obviously, any attempt to meet these conditions by imposing unreasonably low speed-limits can be only a failure. A speed-limit such as 10 or 15 m.p.h. on the open road would be an absurdity and an economic crime, yet under such special conditions as those cited above such speeds should be and are actually adhered to by all competent drivers. It is believed that the only sort of traffic regulation which can meet these conditions is one which will place the responsibility on the driver by requiring him to keep down to speeds from which he can always stop within distances which are determined by the local conditions. Such a regulation could be enforced by empowering traffic officers to demand that vehicles be brought to a stop at any time within a certain specified distance, these distances, rather than the speeds, to be incorporated in the traffic rules.

The Application of Conveyor Equipment to a Small Production Plant

By H. P. Harrison[1]

Production Meeting Paper — *Illustrated with* Photographs

TO install conveyors in a going automobile manufacturing plant of moderate size, without interrupting production, and with a minimum amount of rearrangement of the plant and an investment commensurate with the saving to be effected, was the problem, the solution of which is herein described. The conditions that determined whether power-driven or gravity-actuated conveyors should be used are discussed and the various types required for handling raw stock, for machining operations, for sub-assemblies and for finished assemblies are indicated. Among the operations for which conveyors were found particularly advantageous are those of handling cylinder castings from the storage of raw stock to the stockroom for finished parts; carrying cylinders between various machining operations and from the inspection bench to the storeroom for finished cylinders; machining transmission cases; carrying rear-axle gearcases through machining operations and delivering them to the starting end of the axle-assembling line; handling parts between departments and machines; assembling transmissions, engines, and front and rear axles; carrying axles to the washing and paint-spraying machines, thence to the chassis assembling line; handling the trimming of open bodies; the final conveying of chassis and finished cars; and handling the finished cars through the final-inspection and touch-up operations. The conclusion reached is that the use of conveyors not only pays, but pays well.

[1] Master mechanic, H. H. Franklin Mfg. Co., Syracuse, N. Y.

Fig. 2—Delivery End of Cylinder Elevator

Fig. 1—Feeding End of Cylinder Elevator

IN attempting to adapt rapid production methods to the comparatively small production plant the engineer is at once faced with the question, how far conveyor equipment can be applied to his problem. It is necessary first to determine whether the plant has a production large enough to make the installation advisable. In determining the practicability of installing conveyors it is necessary to consider the arrangement of the plant in its present form and the question of possible rearrangement, without too great a cost, in order to allow the material to progress in its logical sequence. The majority of plants that are brought face to face with this problem have been built up in a series of units, as production requirements have increased, in such a way that the department arrangement has been the result rather of the addition of buildings than of the outgrowth of a definite plan for economical production. It may safely be said that there is no plant manufacturing automotive parts that is too small to consider the installing of some conveyor equipment as an aid to cost reduction. The question, how far the installation of conveyors

should be carried, is a matter that can be determined only by a careful study of each individual case.

The problems of the Franklin Company and the way in which they were worked out are shown in the accompanying illustrations. In considering the problems at the Franklin plant there were several important requirements that had to be fulfilled in making the conveyor installation:

(1) An elastic schedule of from 20 to 60 cars per day
(2) A minimum amount of plant rearrangement
(3) An investment commensurate with the saving to be effected
(4) Ability to make the installation without interrupting production

Before we had given the matter serious thought we operated our shops on the lot system of production, and naturally in order to use conveyor equipment in the several departments it was necessary first to abandon this practice. The various operations must be balanced in such a way that each work-station along the conveyor line has, as nearly as possible, the same time-period as every other station. The type of conveyor selected was intended to meet, as closely as possible, these requirements.

It might be well at this point to note one fact that we have since learned enters largely into determining whether the conveyor shall be power-driven, or simply hand-operated by gravity. In installing several conveyors we first selected a power-driven unit for conveying machined parts and assembled parts between the various machines upon which the operations were performed. These conveyors have since been removed and replaced with others of the gravity type. The reasons for the failure of power-driven conveyors in the locations referred to will be explained more in detail later, but it can safely be stated that for the average plant of small production it is not practicable to use power-driven conveyors where the operations are not performed directly on the conveyor lines.

Fig. 3—Belt Conveyor First Installed for Handling Cylinders Through Machine Operation

Fig. 4—The Present Double Gravity Line for Handling Cylinders

A discussion of the conveyor installation at the Franklin plant will probably be made clearer by illustrations. The subject, accordingly, will be treated in the following order: (*a*) Raw-stock-handling conveyors; (*b*) conveyors for machining operations; (*c*) conveyors for sub-assemblies; and (*d*) conveyors for finished assemblies. This, of course, is the logical order in which the stock is progressed through the plant.

The first installation is the handling of cylinder castings from the storage of raw stock to the stockroom for finished parts. Fig. 1 shows the feeding end of the cylinder elevator, the function of which is to elevate the cylinders from the basement floor to the third floor of the same building and deliver the castings to the feeding end of the cylinder-machining line. The elevator itself is automatic in operation and is arranged to pick up the cylinders, four on a pallet, without the attention of an operator. The cylinders are delivered on a curved section of gravity conveyor on the third floor, as shown in Fig. 2. The section of gravity conveyor in the foreground is fitted with an automatic electric switch, which stops the operation of the conveyor as soon as 4 loaded pallets rest on it, and sets the conveyor in operation again as soon as those pallets have passed off. This arrangement prevents the piling up of cylinder castings at the delivery end of the elevator. Before installing the cylinder elevator it was necessary to truck the castings several hundred feet horizontally, from their storage space to an elevator, bring them to the third floor and repeat the horizontal travel in order to deliver them at the point where the machine operations began. The elevator, of course, removes any necessity for this handling.

Conveyor for Carrying Cylinders

The first conveyor that we installed, to carry cylinders between the various machining operations, is shown in

Fig. 3. This conveyor is composed of an endless belt along which are interposed sections of roller conveyor under which the belt itself passes, thus allowing the cylinders to collect in certain quantities at the points occupied by the rest stations. The purpose of this installation was to move the cylinders mechanically from one operator to another and still allow some elasticity with regard to the number of cylinders carried between operations. We had already found it impossible to balance exactly the time required for each operation or to combine the operations so that the time would approach the required unit; and the work-station idea seemed to be the logical method of allowing for this discrepancy of time. When the system was put into operation we discovered at once that we could not exert sufficient driving power on the belt to pull it through the rest stations, which I believe numbered 14 at that time. The internal friction of the belt, occasioned by so

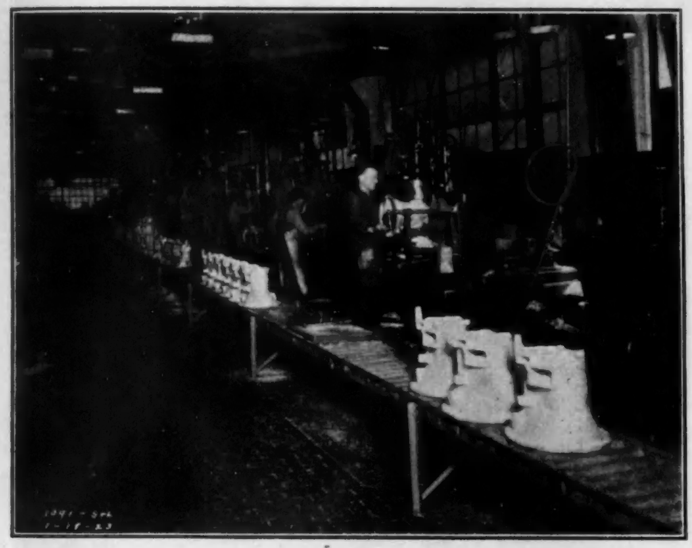

Fig. 5—Gravity Line for Transmission Machining Line

many bends around small-diameter rollers, could not be overcome by the surface contact of the belt with the driving pulley. Midway of the machining line is a group of internal grinders, 10 in number, all of which had to be served with unground cylinders. The operators of these machines had to have some means of getting rid of the cylinders after they had been ground. Here again we found that the belt idea was far from ideal for accomplishing this result; in fact, we actually had a single-track road on which to handle a double line of traffic. This conveyor was kept in operation but a short time, as we immediately began a re-analysis of the job to determine the proper type of conveyor to overcome the troubles of this nature. In Fig. 3 you will note a large number of stock boxes along both sides of the conveyor, in which it was necessary to store a small reserve supply of cylinders in advance of each operation so that, in case of minor shutdowns, the operators would not be without stock.

Fig. 4 shows the double line of gravity conveyor that we finally decided would meet best the requirements of the cylinder-machine line. This conveyor extends the entire length of the line and is divided into three sections, each having a slight pitch to assist in propelling cylinders forward. The idea of dividing the conveyor into sections was to provide convenient passages through the line at these points and to maintain the required slope without making the delivery end of the conveyor

Fig. 6—Gravity Line for Rear-Axle Gear Case

too low. This installation has been in operation about 6 months and is now operating perfectly. It is not necessary to store cylinder castings anywhere except on the conveyor, as a sufficient number of cylinders to meet the requirements of each machine operator are always on the conveyor, even though the machine at the preceding station may have been down for several minutes. This is an excellent illustration of the point I mentioned earlier with reference to our inability to move parts mechanically between machine operations that were not performed on the conveyor itself.

Still another section of conveyor, installed in the cylinder department, was intended originally to carry the finished cylinders from the inspection bench to the storeroom for finished cylinders on an adjacent floor. This was an overhead-cable type of elevator having the feeding and delivery ends for the attachment of the castings lowered to a point conveniently within reach of the operator and extending directly along the ceiling of the room for the remaining distance. Unfortunately we have no illustration of this conveyor, as it was removed shortly after it had been installed. The reasons for its failure to operate properly were that no storage space whatever could be provided for finished cylinders be-

Fig. 7—The Transmission Assembly Conveyor

FIG. 8—CRANKCASE AND ENGINE ASSEMBLY LINE

tween the end of the machine line and the stockroom, and that the last operator on the machine line could not be at the proper point to hang the cylinder castings as the carrier hooks passed that station; a third reason was that there was no attendant stationed at its delivery end all the time. Its failure to suit our conditions can best be summed up by saying that we were unable to synchronize the production of cylinders and the positions of stock men closely enough, without requiring the services of each of the men for a longer time than would be required to move the cylinders manually between the points served. Shortly after attempting to put this conveyor into operation it was decided to dismantle it, and to move the cylinders by truck from the cylinder machine line to the stockroom. In summarizing the results obtained by the installation of cylinder-handling equipment, it may be well to state that we actually reduced the number of cylinder castings in process by 2000.

GRAVITY CONVEYOR FOR TRANSMISSION CASES

Another illustration of what can be done with a simple section of gravity conveyor is shown in Fig. 5. This is the machining line for the transmission case, and offers a good example of what must be accomplished in balancing operations in order to handle the part progressively; and by progressively I mean the advancing of the part directly from one operation to the next without maintaining a large supply of stock between the operations. Before installing the gravity line and arranging the machines in their proper sequence it was often necessary to have 700 to 800 transmission cases in process in order to assure a uniform production at the desired rate. Since the rearrangement of the machine line and the installation of the gravity conveyor we need not have more than 150 transmission cases in process to meet our maximum production requirements. A total of 35 operations on this transmission case are performed by 12 men, one man in some cases covering as many as 3 machines in order to take care of his share of the operations. This is probably one of the best illustrations that we have of the necessity for balancing machining elements in progressive manufacturing. Incidentally, the cost of machining transmission cases diminished 20 per cent with this installation.

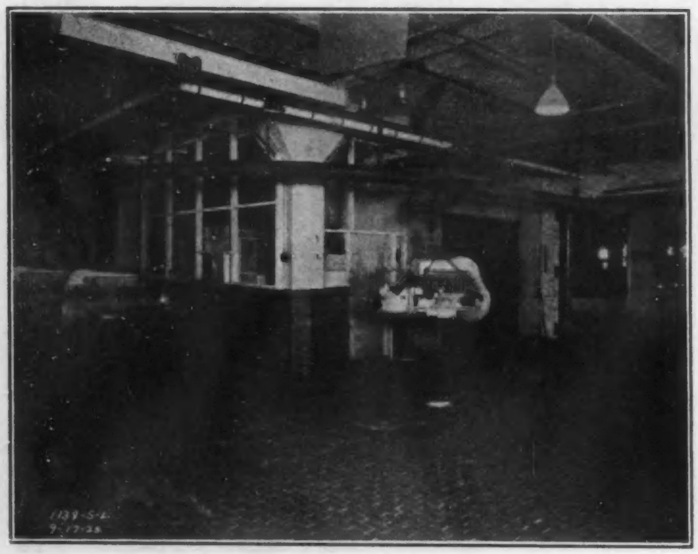

FIG. 9—THE ENGINES ARE MOVED FROM THE ENGINE ASSEMBLY TO CHASSIS ASSEMBLY BY MONORAIL

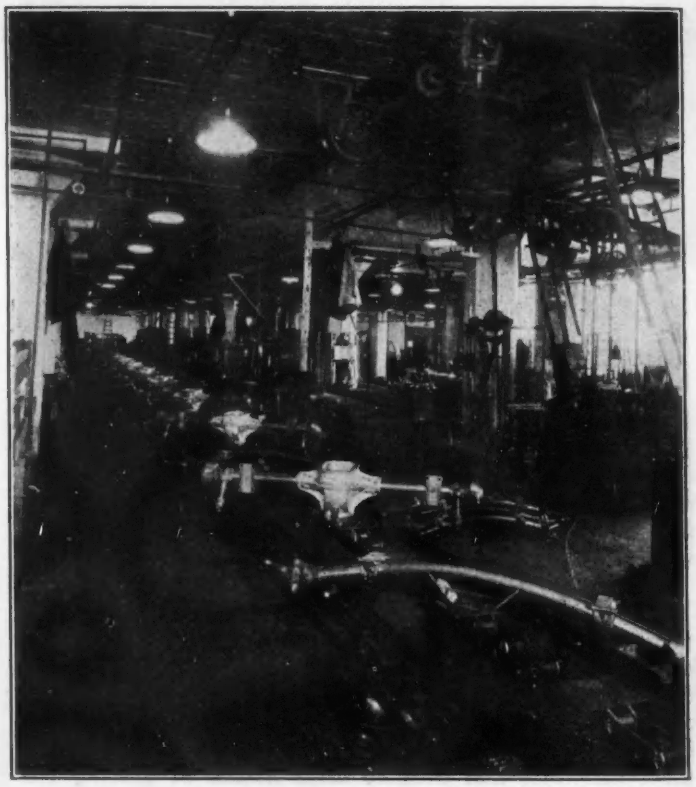

FIG. 10—MAIN LINE OF AXLE-ASSEMBLY CONVEYOR

The next illustration, Fig. 6, is similar to the one just explained on the transmission-case line. The rear-axle gearcase is carried through all the machining operations and is delivered to the starting end of the axle-assembling line. The most important point accomplished here was a very material reduction of the number of castings in process, as well as a considerable reduction in the cost of labor on account of the various operations being properly balanced. There are, of course, a large number of places throughout the plant where gravity conveyors are employed for the handling of parts between departments and between machines, but it is not necessary to discuss them in detail as they are similar to the examples already shown.

The next type of conveyor that enters into the discussion is the self-propelled type, on which all operations are performed on the conveyor. Fig. 7 shows a straight-

FIG. 11—FRONT-AXLE ASSEMBLY CONVEYOR

line power-driven chain conveyor for the assembling of transmissions. This conveyor, in its operation, resembles a long moving bench on which are carried a number of duplicate fixtures that will accommodate the transmissions in each of the assembly positions. The transmission case is placed in the assembly fixture at the far end of the conveyor and the various parts are assembled into it as it proceeds along the length of the conveyor frame until it reaches the delivery end, where it is taken off and sent to the engine-assembly department. The empty fixtures are returned underneath the conveyor, where they can be readily seen in the illustration. The design and installation of this conveyor did not present

FIG. 12—REAR-AXLE ASSEMBLY CONVEYOR

any particular difficulties except that the assembly fixture had to be made to fill a number of different requirements. How well the conveyor fulfills the conditions can best be indicated by the fact that after putting it into operation we found that we could produce our maximum schedule with 50 fewer transmissions in process and with 18 per cent less labor-cost than before.

It might be well to state at this point that we, at least, believe that one of the most important points to be gained by the use of conveyors of this type for assembling purposes is that the department foreman knows in advance exactly what his production will be at the end of the day, a fact of which he is most certainly ignorant when conveyors are not used.

The engine-assembly conveyor, shown in Fig. 8, consists of a U-shaped conveyor, on which the crankcase-assembly operations are performed on the right leg and the other operations on the left leg, the two legs traveling in opposite directions. Both conveyor lines are driven from a single drive-head so that there is no trouble in maintaining synchronism between the two lines. Some of the operations performed in assembling our engines require the use of an assembly jig in which the engines can be inverted, as is clearly shown in Fig. 8. These jigs are the result of several years of develop-

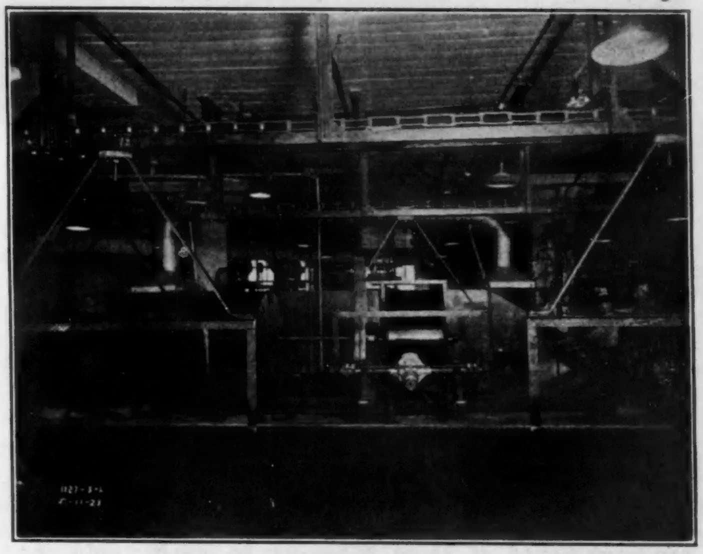

FIG. 13—AXLE WASHING AND LOADING END OF AXLE PAINT CONVEYOR

ment and were in use for some time before the conveyor line itself was installed. This conveyor is a good example of the simplicity of applying the conveyor idea to the average well equipped assembly unit. In our case it was necessary only to lay the channels and install the drag chain and driving end to complete the job. No difficulty whatever was experienced in putting the conveyor into operation, and the men along the line seemed to appre-

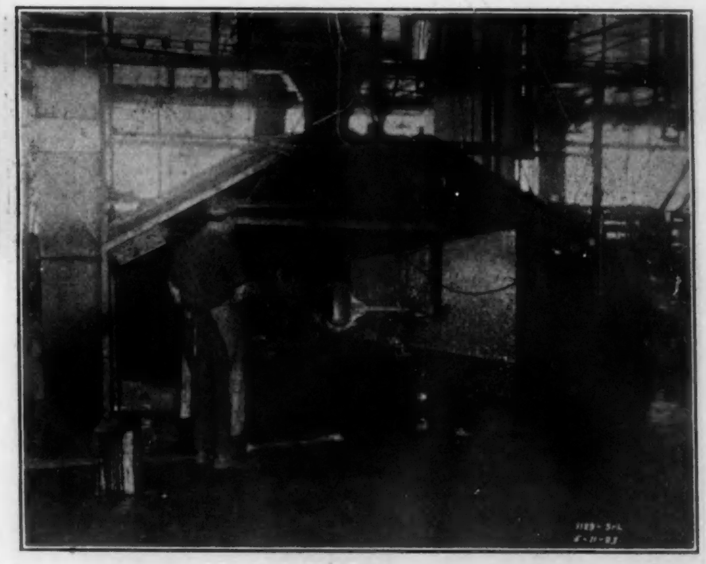

FIG. 14—SPRAY STATION ON AXLE PAINT CONVEYOR

FIG. 15—AXLE PAINT CONVEYOR

ciate the fact that it was no longer necessary to drag the heavy trucks from station to station. Here again we were able to realize a reduction of 15 per cent in the labor cost of building engines.

When the assembled engine was delivered from the end of the assembly line it was our practice to use two movemen to transport it to the engine conveyor that runs parallel to the chassis-assembly line in an adjacent department. This resulted in a considerable strain on the trucks and very often in an accident, in which the engine would be upset, with the danger of serious injury to one of the movemen. Fig. 9 shows a simple monorail installation with an electric hoist, over which the engines are now moved, it being necessary to employ only one man and with entire safety to him.

ARRANGEMENT TO ALLOW PROPER FUNCTIONING

In considering the arrangement of our plant that was necessary to allow the conveyor equipment to function properly, we decided to make a new department for the manufacturing of all parts required for both front and rear axles. This department was located where the several assembling operations on both front and rear axles could be performed along opposite sides of a long single-chain conveyor, shown in Fig. 10. This conveyor, by the way, is the only example of a power-driven conveyor that we have in our plant whose only function is the moving of the work between machine operations; and it may be well to state at this time that I still believe the statement, which I made earlier in the paper, that ordinary gravity means of sliding these parts along would have functioned as well as, if not better than, the power-driven conveyor. However, we have allowed this conveyor to remain because we did not have so much difficulty in synchronizing the operations. The axles are built on this conveyor only so far as is shown in the illustration. For the rest of the operations they are removed from the conveyor, the front axle on one side and the rear axle on the other, and carried by a small overhead trolley to a station at the starting end of what we call the final-axle-assembly conveyors. Fig. 11 shows a conveyor of this type on which the operations of assembling connecting-rods, steering-knuckles and the like are performed. This is a double-chain type of conveyor having heavy steel plates for cross-members, which are so made in order to resist the heavy hammering that is necessary in assembling the springs into the spring-clips and aligning the springs before finally bolting them into place. The speed of this conveyor is synchronized with that of the conveyor shown in Fig. 10 so that there is no surplus of axles between the two. The completed axle is removed from the conveyor by the overhead hoist, shown in the foreground, and is fed directly into the washing machine, where it is washed preparatory to painting. The inspection operations of both the front and the rear axles are conducted directly on the ends of the assembly conveyors. Fig. 12 shows the rear-axle conveyor, upon which the final-assembly operations are performed. Here again the conveyor is made extremely heavy to withstand the heavy pounding necessary for the assembly operations. The axle in this case is moved lengthwise along the conveyor, instead of crosswise, for the operators' convenience in performing the assembly operations. This conveyor also delivers the axle directly to the overhead line that transports it to the washing machine, which can be seen at the extreme left of Fig. 12. Fig. 13 shows the washing machine through which the axles pass, as well as the feed and delivery ends of the axle paint conveyor. Axles are removed from the end of the washing machine by an electric hoist, and are

FIG. 16—FIRST LEVEL OF BODY TRIM LINE

FIG. 17—SECOND LEVEL OF BODY TRIM LINE

hung directly on the carriers of the conveyor. They are moved along this conveyor to the right, to the spray booth shown in Fig. 14, where they receive a heavy coat of paint, then through this spray booth to the end of the room and back in a parallel line on the other side of the post line. The arrangement of the axle-paint conveyor as a whole can best be seen in Fig. 15, which shows the axles returning from the end of the room after the paint has been applied to them. The axles are unloaded at this point and are transported by trucks directly to the chassis-assembly line, which is on the same floor as the axle-manufacturing unit. By concentrating the manufacture of axle parts and finished axles into one unit we avoid a large amount of stock-moving of very bulky parts that gave considerable trouble under the old method. We have obviated the principal excuse offered by the several foremen interested in the manufacture of axles and parts by putting the entire manufacturing unit in one location. There can be no excuse for the shortage of some part manufactured elsewhere in the plant, inasmuch as all parts are manufactured in this one room, and a more uniform production of axles is obtained. We experience no trouble in meeting the

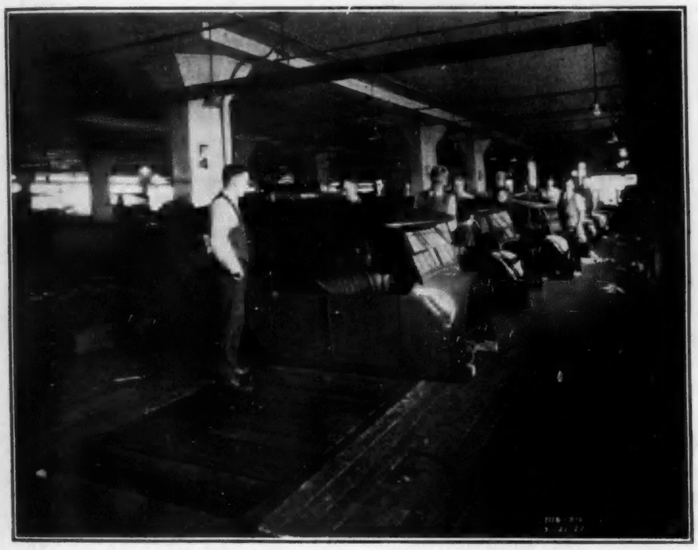

Fig. 18—Floor Level of Body Trim Line

maximum production requirements and could build more axles if they were needed. We have reduced the actual number of axles in process by about 500, including fronts and rears, and aside from reducing the moving cost we have lowered the actual manufacturing cost of axles by 15 per cent. The operation of this conveyor leaves no doubt whatever in our minds as to the practicability of the unit system of manufacture, for a large portion of the parts involved, even in plants of the capacity of ours.

Handling the Trimming of Bodies

One of the most interesting installations recently made is a conveyor for handling the trimming of open bodies. Fig. 16 shows the first stage. The conveyor itself is divided into three stages, each located on a different level, the elevation of the body being fixed according to the needs of the operations being performed on it at that particular point. The first section is elevated 24 in. above the floor and brings the body to the proper height for such operations as installing the wiring back of the dash, putting in the buttons for side-curtains, and the like. You will notice that the conveyor line is free from crosswise obstructions so that the operator can work

Fig. 19—The Axle Loading Station

inside the body with his feet on the floor without danger. The body is loaded on the starting end of the conveyor with a small electric-hoist and travels the entire length of the conveyor line mounted on a low four-wheel truck, which can be seen in the illustration. On the second elevation, which is shown in Fig. 17, the body is brought down to a height of about 10 in. above the floor, for the convenience of the trimmers who must necessarily work over the rear end of the body and over the sides. A false floor was built around this conveyor line to bring the operator to the proper level in order to avoid cutting through the floor for the return chain. This idea was simply an expedient to avoid a complication of local conditions where the return chain would have had to pass over the top of one of the railroad tracks that enter the building on the floor below. The first and second sections of the body-trim conveyor are driven from a single unit through bevel gears, the shaft of which can be seen in the foreground of Fig. 17. Building the top directly on the body required that the body be carried as close to the floor as possible. The way in which this was accomplished is shown in Fig. 18. You will notice that the body truck travels in an open space between adjacent flights of slat conveyor so that there is actually no opening in

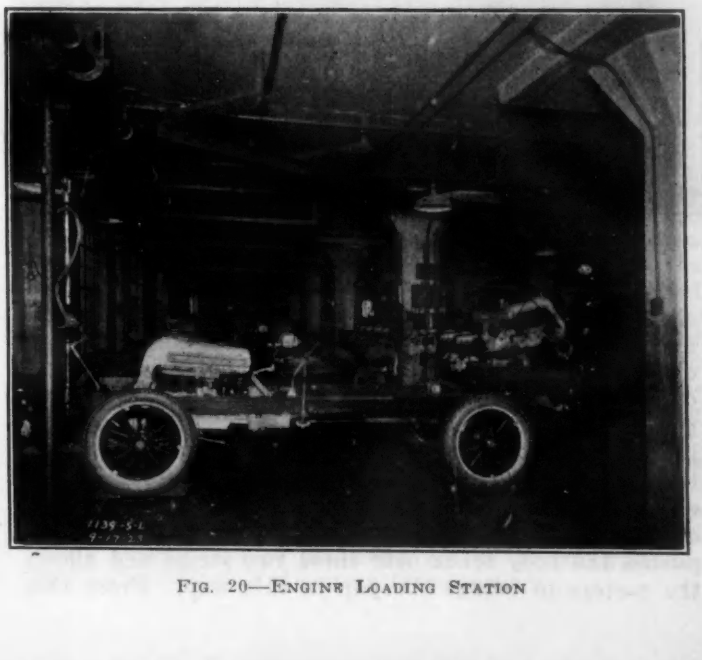

Fig. 20—Engine Loading Station

FIG. 21—PRESENT CHASSIS CONVEYOR LINE SHOWING ITS RELATION TO ENGINE AND FINISHED CAR LINES

the floor at any point around the body, although the body is continually moving forward at the desired rate. It was necessary to build this type of moving floor to protect the top-builders who, of course, must work at all points around the body. The bodies, with the same trucks on which they traveled the length of the conveyor, travel by gravity around a curve, which is at the rear of this illustration, and feed into the openings between the intervals of slat conveyor. It is necessary, of course, at this point for the trimmers to guide the body so that it will be picked up properly by the driving edge of the

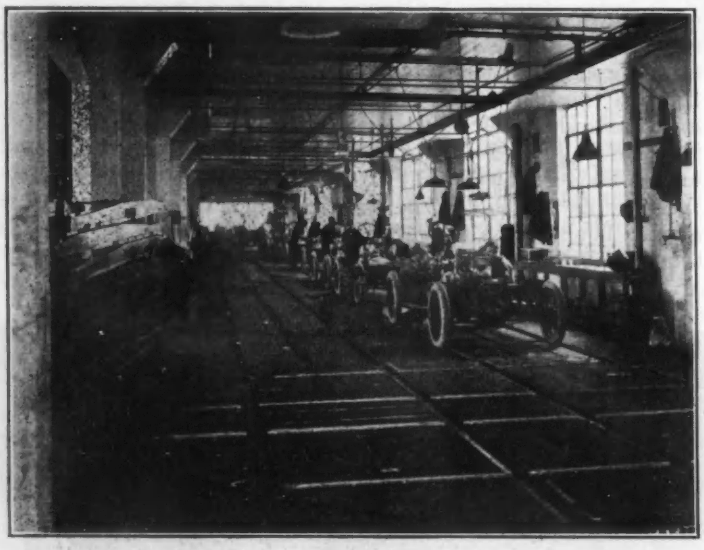

FIG. 22—A SECTION OF THE CHASSIS CONVEYOR LINE NOW DISCONTINUED

slat conveyor. This driving edge, which is protected by an angle-iron binding, drives directly against one side of the body truck. In the foreground is shown the end of the top-building line where the body is delivered complete ready for loading on the chassis. The method of lifting the body truck over the openings in the channel track through which the slat conveyor passes is shown quite clearly by the two strips on either side of the opening. The thrust of the driving edge of the conveyor pushes the body truck over these two strips and allows the casters to bridge the gap in this way. From this point they are pushed to the loading deck which is directly adjacent to this point.

The chassis and final-car conveyors are the largest that we have, and have been in operation the longest. The chassis conveyor, as it is now operated, is in the form of an L. The starting end of the line is shown in Fig. 19. At this point the sill assembly is mounted on the chassis truck and the axles are fitted. Fig. 20 shows the corner of the L, the point at which the engine is mounted. From this point forward the chassis travels in a straight line to the point where the body is loaded. Fig. 21 is a view of the chassis line taken from the end opposite to that of Fig. 20, that is, looking toward the point where the engine is loaded, and shows in the foreground a chassis that is ready to enter the body-loading station. The trucks on which it has traveled up

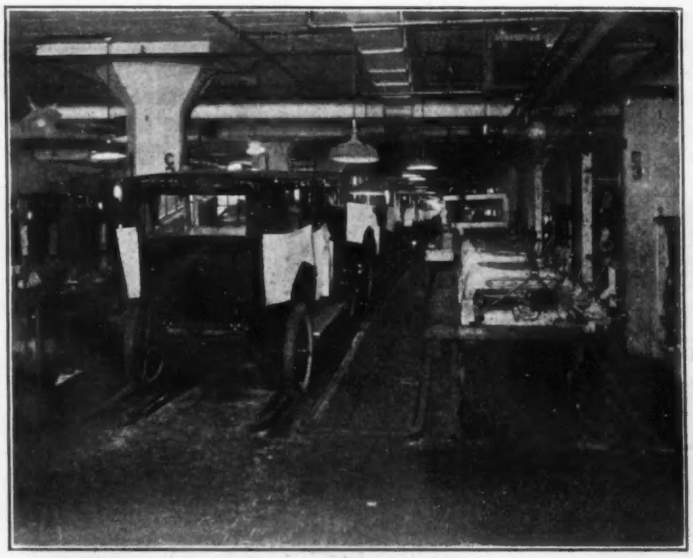

FIG. 23—STARTING END OF FINISHED CAR LINE

to this time are at present removed by the inclined channels shown, but this arrangement is only temporary, and we plan to keep the chassis on the truck until after the body has been loaded and the car is ready for delivery to the final-car line. The original chassis-layout was somewhat different from the present L-shaped arrangement on account of the larger number of operations

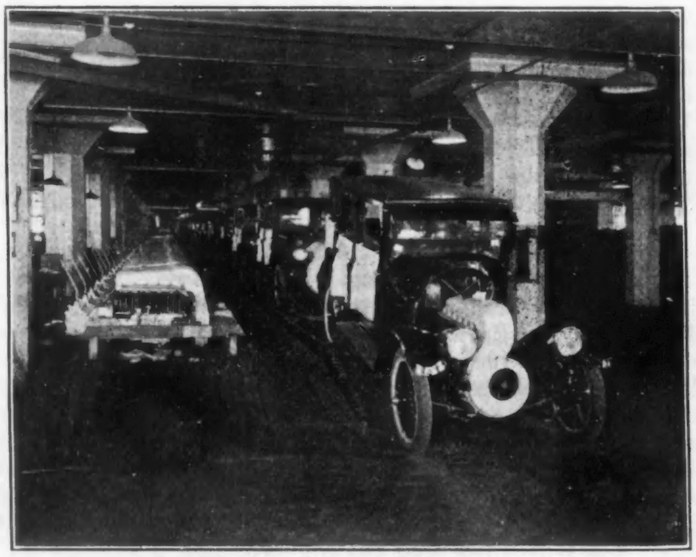

FIG. 24—DELIVERY END OF FINISHED CAR LINE

that were necessary when this installation was first made. A very good idea of the relative locations of the chassis, engine and final-car lines may be obtained from Fig. 21. The chassis line is traveling in the opposite direction to that of the other two lines. Fig. 22 is a view of the one section of the old chassis-line that has since been removed, the change in layout resulting in the shortening of the travel of the chassis during building by several hundred feet, and in reducing considerably the number of chassis in process, while at the same time making available about 5000 or 6000 sq. ft. of additional manufacturing space.

The Final-Car Line

From the end of the chassis line, after the body has been loaded, the car is moved by a small transfer-car directly to the entering end of the final-car line, shown in Fig. 23. This photograph also shows the relative location of the engine-conveyor line, which supplies engines to the proper point along the chassis line. The final-car and engine conveyors are both of the belt type, the cars progressing on the belt without their wheels revolving. This type of conveyor was originally chosen to allow certain drilling operations to be performed through the spokes of the wheels, and has given remarkably little trouble considering the extremely heavy load that it carries. Although it has been difficult at times to maintain a uniform rate of speed on this conveyor on account of variations in the tension of so long a belt occasioned by changes in weather conditions. Fig. 24 shows the delivery end of the final-car and engine lines. Much might be said with reference to the advantages of using conveyors for chassis and final-assembly work, but I believe we all appreciate just what it means to any manufacturer who installs a conveyor system, in eliminating the delays occasioned by stock shortages, inability to keep the floor well arranged and the impossibility of predicting exactly the rate of production that can be obtained from the department. In our case the conveyor equipment has paid large dividends, and since its installation we have operated with nearly 40 per cent less labor-cost than before.

Practically all the conveyor illustrations shown have been installed within the last year, with the exception of the chassis and final-car conveyor-lines. We are absolutely "sold" on the idea that conveyors can be made to pay dividends even with a production such as ours, and

Fig. 25—A New Line for Final Inspection of Cars Just Being Installed

are still making careful studies of other departments with the idea of installing additional conveyor equipment of some sort.

We are making one extensive installation at this time, which is not yet ready for operation, for handling the finished cars through the final-inspection and touch-up operations. The present condition of this conveyor is shown in Fig. 25. It is simply a drag-chain conveyor about 360 ft. long, which will be provided with the necessary stations throughout its length for handling the operations required.

I simply mention this in passing, in order to impress upon you the idea that although our experience with conveyor equipment has been short, we are convinced beyond a doubt that it pays and pays well.

ACCIDENT PREVENTION

THE day has gone by when safety work was considered an humanitarian fad; the experience of employers who have undertaken it along rational lines proves too plainly that it is good business. Gone by, too, is the day when its economic value was measured solely in terms of damages or compensation saved, or lessened insurance cost. Considerable as the direct costs of accident may be they are much more expensive to an employer through the lost time of the injured men, through the interruption of the work of others caused by accidents, through the waste of material and the spoiling of product by new men, through their lessened production and through the time of foremen or others diverted for their training. All such interferences with the ordinary course of a plant's work cause a loss in efficiency that is distinctly measurable in dollars and cents. And the overhead expenses are running along just the same, but without the same degree of offset as had the accidents not occurred.

Not only does safety work cut down the loss in efficiency due to accidents but it tends to increase output. The less time a workman has to devote to avoiding injury, the more he has to give to production. And the spirit of cooperation among workmen developed by organized efforts is also plainly reflected in a greater interest in their work.

Another costly feature of accidents is found in the part that they play in labor turnover, that apt expression for the opposite of a stable working force. Every employer knows how expensive this turnover is; how important it is to the general efficiency of his plant to keep his labor force as intact as possible. The influence of safety work on labor turnover through lessening the number of employes injured and through promoting better relations between employer and employed is especially needed at this time when labor conditions still react, even at this late date, to the disturbing effects of the war.

When we stop to consider these varied ways in which the prevention of accidents is of importance to industry, we cannot fail to appreciate the real value of accident prevention in industry and feel a responsibility for seeing that an efficient safety organization is producing results in our plants.—David Van Schaak in *American Industries*.

The Human Element in Production

By W. F. Jameson[1]

Production Meeting Paper

PRODUCTION is largely dependent on the human element, which is called by different terms according to the degree of intelligence expected from persons of different ranks; varying from ordinary stupidity among those of low intelligence to the "errors of judgment" of those higher up, it has been defined as a "temporary lack of application of one's attention to the thing at hand," and its effect on workmen of various temperaments is to lower production. Concentration is shown to be the central truth and the cause of one man's superiority to another. When supplied with an incentive, such as that of feeling that he is working for himself, a workman will concentrate his attention on his work with profit both to himself and to his employer. But apparently insignificant things preying on his mind will often cause a lack of concentration. Education is an endless process of growth and accomplishment. The motive back of the desire for a college education is the gathering of a fund of knowledge and experience that will enable one to cope better with the problems of life. A going manufacturing company offers real problems for solution and obstacles to be overcome. Every job can be made a training school of experience if the holder will make it so; the production game furnishes everything necessary for growth. Inertia is the great obstacle, while autosuggestion, on the other hand, is of great assistance in instilling spirit into one's work. The determination continually to learn something new, to overcome all obstacles and to take advantage of opportunities that are presented will not only make the time pass quickly but will also increase efficiency.

THE human element has always been and necessarily always will be a most vital factor in every undertaking that marks the progress of civilization. Production is one thing that surely has an influence on the world's progress. We need offer no apology, then, for considering the human element in its relation to production in general and, more specifically, to the high-powered production of the automotive industry. But before we consider this subject let us at first make sure that we have a common understanding as to what is meant by the expression "human element." By reference to the correspondence files of any concern that purchases fabricated material from outside sources, you will find the term used with reckless freedom, with the apparent belief that it is a complete and satisfactory alibi in every instance in which the product does not measure up to standard quality.

The expression at times is also considered somewhat synonymous with a lower grade or less intelligent class of workmen. This is a mistake, as its influence is felt from the lowest ranks to the highest. We use such terms as "error of judgment" when thinking of the semi-executive class, and when we get into the executive class proper such things are to be expected, if we accept Elbert Hubbard's definition of an executive as "one who makes quick decisions and is sometimes right."

Tracing back the more common interpretation of the meaning of the term "human element," we find it to be a *temporary lack of application of one's attention to the thing at hand;* and the attitude of one's mind is the controlling feature that directs one's attention to the thing at hand. Far too little consideration has been given to this subject in the case of the ordinary workman while he is on the job, yet much depends on just that. We have overlooked the possibilities of training the mind behind the man; much as man overlooks nature in her majestic moods. We see the sun rise and the lightning flash, and hear the thunder roll, but we are blind and deaf so far as being impressed by such wonders is concerned. Our sensibilities become calloused toward an oft-repeated occurrence. We have thought of workmen as so many hired hands for so long that we have thought ourselves into expecting no more than their hands; and in too many instances they reciprocate. We have made motion studies of hands and have accomplished wonderful results from a production standpoint, but are there not still greater results to be obtained by cultivating more than the machine side of the man?

It is fully granted that there are a host of workmen who, from observation, show no tendency or inclination to exhibit any more than a machine side, and much credit is due those systems which utilize this phase of human energy in bringing about a high state of efficiency in production; but considerable additional cost goes hand-in-hand with such methods of production, an instance of which may be cited in the fact that, in order to guard against a possibly defective piece's entering a sub or main assembly, the items composing that assembly must have 100 per cent inspection; and many inspection operations require more than the machine side of a man. Estimate, then, the cost of inspection in an automobile plant, taking into consideration the fact that numerous items can be handled and placed in assemblies in less time than it would take to handle a single item for inspection. The number of inspectors required would be practically equivalent to the number of employes in the production force.

Importance of Right Thinking

We find, however, that the majority of workmen are capable of thinking, and that fact in itself lends encouragement to the proposition of coaching them to think rightly. Furthermore, it is surprising how readily men will respond to treatment of this nature. We cannot deny that a man who takes an interest in his job and applies himself to it will turn out better work with fewer mistakes and a larger output. There are plenty of good men who take an interest in their work when they apply themselves to it, but the difficulty lies in getting them to apply themselves consistently; yet it is not so difficult after all if the proper methods are used. We can hardly fail to recognize that civilization is fast drifting into a new epoch of thinking. Many teachers

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are spreading various gospels among the people. The Hindoo, with his "Peace, Peace, Peace," is taking hold of the minds of many, but when we strip these various movements and teachings of their commercializing cloaks, we find that one central truth, though perhaps expressed in different terms, lies at the heart of all. In fact, this central truth can be expressed in one word, *Concentration*. Though, at first thought, there may seem to be little connection between concentration and the human element in production, let us see if we cannot prove the following assumptive facts to be not only real facts, but sound working principles that can be proved in actual practice.

(1) Every man has a great storehouse of latent power and energy, the key to the door of which is concentration

(2) When a man begins to draw on the storehouse of energy that he possesses, his work and efforts stand out above his fellow-workman's in remarkable contrast

(3) It is possible to teach any man how to use the key of concentration, but he is not likely to use it unless he has an incentive to do so

(4) Of all incentives the most productive and most lasting is the feeling that one is working for himself

(5) It is possible for a man to become saturated with the thought that he is working for himself while on the payroll of his employer, with profit to both as the result

(6) It is easy to sell men to the foregoing principles but to keep them sold requires repeated efforts on the part of the salesman who himself must first be permanently sold

(7) In the production field under present conditions the foremen are the logical salesmen, and they themselves should keep each other permanently sold by get-together meetings for this special purpose

In order to grasp fully the import of the first assertion, we must digress for the moment from things mechanical, and border on the realm of what some might term religion, while others would term it universal law. Terminology means little, as is illustrated in a verse or two from Dr. Carruth's poem, entitled "Each in His Own Tongue:"

A fire-mist and a planet,
  A crystal and a cell,
A jelly-fish and a saurian,
  And caves where cavemen dwell;
Then a sense of law and beauty
  And a face turned from the clod—
Some call it Evolution,
  And others call it God.

A picket frozen on duty,
  A mother starved for her brood;
Socrates drinking the hemlock,
  And Jesus stretched on the rood;
And millions who, humble and nameless,
  The straight hard pathway trod:
Some call it Concentration,
  And others call it God.

Development of Well Balanced Brain

Science teaches us that there are 43 distinct brain areas or faculties. These centers can be developed into an active state or they may be left dormant. The greater the number of brain areas we live in and the more evenly balanced their capacity, the more capable we are, but, as a matter of fact, there is not a perfectly sane man on the face of the earth. We are all lop-sided in some of our faculties. Concentration, then, is the directing of the blood to the various brain centers at will and the shutting out completely of everything else, except the thing we wish to center our attention on. If it were easy to do this to a marked degree we can hardly estimate the power and force that would be at our command. We could tap the reservoirs of universal knowledge through our subconscious minds. But this must remain a dream at our present stage of development, though a dream not incapable of realization in a not far distant generation.

Let us return to earth then and see what even the first steps in this direction will do for the shop workman. Here is a man at a bench, with nothing particular on his mind. His hands have moved in certain directions often enough to have acquired a habit to some extent. His mind is like a sensitized camera-plate, subject to impressions from any angle. Thoughts fly in and out of his mind at random, any one of which may remain just long enough to create a mood, which is nothing more than an impression taking a permanent set for the time being; and we know what moods will do and how they are reflected in one's work. Perhaps some word of profanity from a nearby fellow workman fell on his ear early in the morning, but it was enough for a slight impression of dissatisfaction to gain weight, and in a short time everything is "all wrong" and that feeling of "to hell with this job" shows up in his work.

Such uncontrolled thinking and misdirected energy are the unknown quantities of the day's production, because of which poor workmanship occurs and for which the human element gets the blame. But next to this workman is one that, by conscious or unconscious training, has learned not to register unwelcome impressions. A deaf ear is turned on expressions that he knows by experience would change a constructive into a destructive mood. He selects the thoughts that he allows his mind to dwell on. The day's output from such a man can be banked on, both as to quality and quantity. The boss points him out as a good man. His name is mentioned frequently when reliable men are wanted for certain operations. Perhaps a more responsible position opens up; again his name is mentioned and he gets an opportunity to advance. This is every-day experience and takes place in any average plant; and it is readily seen that the one mark of distinction between the two workmen cited is the fact that the first makes no attempt whatever to select the thoughts that he allows to occupy his mind, while the second concentrates to the extent that worthless impressions or thoughts are purposely barred from registering on his brain. If just this amount of attention paid to the matter of concentrating one's mind on the thing at hand will produce the results mentioned, then the more remarkable results from further efforts expended can be little questioned, and more and more the second item mentioned above will come into prominence in that the work turned out and the results accomplished by the man's using this method will stand out in remarkable contrast to the output of one who drifts along from day to day, easily impressed by every passing influence, without the stabilizing effect that is produced by an active faculty of concentration. Watch any man work whose mind is on any what-not subject foreign to his work and no further evidence will be needed to convince one of the truth of these facts.

The third point in the hypothesis is the necessity for an incentive to acquire the habit of concentrating. There is scarcely a thing we do without having a motive behind

it. In fact, if all anticipation, motives and incentives were subtracted from our lives, there would be no excuse for desiring to live at all. A motive is the very first thing a police department sets out to establish when investigating a crime. There was a motive or incentive actuating the first workman referred to above, and that motive is one of the biggest obstacles in the industrial field everywhere.

INERTIA THE GREAT OBSTACLE

This obstacle is Inertia; it is a disease with many people and most of us have attacks of it. The desire for inactivity, rest and ease makes one sluggish. The incentive to satisfy that desire will never boost nor improve production. Such an incentive seldom enters the mind of anyone working for himself. If it does, he knows that failure will be lurking at the door; and the incentive to fight off failure would counteract the incentive of a desire for inactivity. This brings us to the fourth point that working for one's self is in itself a wonderful incentive. It is, perhaps, the most powerful and lasting of all.

There is a stimulation about the thought of working for one's self that results in an added flow of energy and immediate results; and that is what is wanted. The word "stimulation" is used because oftentimes the thought of working for one's self is a greater stimulant or incentive than being actually in business for one's self. Furthermore, if we trace back the real motive behind the almost universal desire to have a business of one's own, we shall find in many cases, and particularly among the working class in the production ranks, that it is an attack of inertia in disguise. They bargain with themselves to work at top-notch speed, in the anticipation of a life of ease when they shall have accomplished certain aims. And again, the halo around the thought of working for one's self disappears when one has entered business for one's self, as there are a great many obstacles to be met that are not taken into consideration beforehand. The individual very often sees only a rosy outcome. The pasture beyond the fence invariably looks greener than the one at hand.

The actual experience of working for one's self with its possible outcome, together with the reverses with which one must meet, does not enter into the proposition, as our fifth step makes use of the thought of working for one's self as applied in an entirely different manner. We come now to the most important and far-reaching point in our analysis. The very nature of the subject takes it out of the slide-rule class; hence the foregoing analysis is only a brief outline leading up to the important point that it is desired to stress: How can we inject into the individual workman the spirit of working for himself, in order that production may benefit by the increase of efficiency resulting from that spirit?

The demand for some such action is becoming more and more acute as the wheels of production are constantly being speeded-up. In the old days a great many men found joy in expressing themselves in their work. The opportunity for this in today's production is not so great because of the fact that the scope of any one workman's operation is much more limited. Many of us remember the days when one workman alone carried through all the operations of manufacture and assembly, incident to the building of engine units complete. He was proud of his handiwork, he felt the responsibility, he had faith in himself; and no man can hold such an attitude of mind without growing and forging ahead. This is one of a number of incentives that have gone by the boards with the introduction of new production methods; hence the necessity for a workable substitute; and that substitute is our fifth point. Let us repeat it: It is possible for a man to become saturated with the thought that he is working for himself while on the payroll of his employer, with profit to both as the result.

The true motive back of a man's desire for a college education is the gathering of a fund of knowledge and experience that will enable him to cope better with the problems and obstacles of the future, with the hope that such training will pay him larger cash returns when he sets out to make a mark for himself. He spends several valuable years of time and good money for this training. The stage setting in college is necessarily artificial. It reproduces as closely as possible conditions in the outside world and teaches the student how to act under these conditions. The student goes through this period of training, graduates with honors, and goes out to sell himself to the world. Not only does he meet obstacles and problems that were not reproduced in college, but he sees a vast difference between the real conditions of business and their reproductions in college; quoting Elbert Hubbard again: "A man can spend four years in college and succeed in spite of it." That would seem quite severe if we were not familiar with Hubbard's style. We do know, however, that success depends entirely on the man. A college training amounts to nothing in some men, while to others it means everything.

Now let us look at another institution located, perhaps, next door to the college institution. It is a going manufacturing concern. There is no make-believe in its set-up. Real conditions exist, actual problems present themselves for solving, numerous obstacles must be overcome. Our first thought is: What a wonderful opportunity for training; and that is just the point; it is. Every job can be made a training school of experience if we will make it so. Every problem we face and master fits us better to meet the next obstacle just as the young oak tree grows stronger with each storm it weathers; otherwise it would never become the mighty oak. Hazards improve one's game of golf. When our efforts are taxed in the accomplishment of any undertaking, we can accomplish the same task a little easier the next time and are prepared for still greater tasks. The more we do the more we can do. It is an endless process of growth and accomplishment. That is the kind of training course industry offers to anyone who accepts it in this light; that is the point we must put over to the workman. Everything necessary for our growth is furnished in the production game, opportunities to solve problems and overcome obstacles that we could not go out and create single-handed; and we absolutely must fight battles if we would win victories. Think, then, of the opportunity every workman has when he is offered such a training course and, instead of having to pay tuition, he is actually paid real money for attending a real school of real opportunities.

VALUE OF AUTO-SUGGESTION

Try to conceive, if possible, a group of workmen passing the time-clock and every click of the clock releasing in each of their minds the following auto-suggestion: "I am going to work for myself today by learning something new about my work. Bill Jones has a harder job than I have and I am going to find out what he knows that I do not; you can take it from me that from now on nothing gets by me. I am going to make myself capable of handling the hardest job in this shop and handling

it better than it ever has been handled. I am going to start my school days over again right here in this plant." What do you suppose would happen if a group of men got a spirit like that instilled into them? Time flies when one is working with such an incentive, and there is a wonderful sense of happiness in one's work when there is a feeling that time is all too short to accomplish what one has in mind. After all, education and experience are about the biggest assets of life, and education is nothing more than the sum total of sense impressions made on the brain. To realize this and take advantage of every opportunity for enhancing our education is surely working for one's own interests, and there is no job that does not offer such an opportunity. We hear a great deal about loyalty to the firm for which we are working, but that is putting the cart before the horse. If one imbibes the thought that one is working for one's own interests and considers one's own development primarily, the company's interests, though considered as secondary, are taken care of with constantly increasing efficiency. The two are inseparable, each depending on the other.

These principles are not new. We simply have not taken advantage of them to the extent that we could and should have. They have been and are being applied here and there to a limited extent either consciously or unconsciously, and you can measure their results every time. As an example of this, a department head came into the office while some of these thoughts were being dictated. He left the office without stating his reason for calling, but returned later to say that his first visit had been to request help on a certain problem but, hearing about the advantages of hunting for problems to solve and obstacles to overcome, he had decided to go out and lick the proposition himself; he returned only to state that it had "worked like a charm." Surely, it will work. It is the working out of the natural law of cause and effect, but there is another force which seems to work in opposition, that we shall put in question form: Why is it easier to form bad habits than good habits? Perhaps it is that there are so many more bad habits than good ones. On the same basis of reasoning, perhaps that explains why so much work finds its way to the scrap-heap, there being only one right way to turn out a job compared with a hundred or more wrong ways.

Concentrating on the fact that one's job is a school of unlimited possibilities is a mighty fine habit, productive of untold good, but, regardless of that fact, if that attitude of mind slips away from us, it may remain absent for a long time, or until some person or incident reminds us of what we are missing. Hence the occasion for the last two statements in the outline submitted, namely: The foreman should train himself to control the attitude of mind of his men while he himself is prevented from dropping back into ruts by "constant reminder" conferences with other foremen.

Once more let us quote Elbert Hubbard, who incidentally was a great exponent of the doctrine of finding joy in one's work. He believed in certain principles of socialism, but stated that they must be brought about by evolution, instead of revolution. This is likewise applicable to the principles herein set forth. It takes good salesmanship to "put across" any idea to a group of men of various types and temperaments, and in this case it should not be attempted, collectively at least, until the group has been 100 per cent "sold," individually, which of course is a big stake to hope for. The idea has been worked out successfully to a marked degree by the foreman's explanation to his "key-men," who in turn act the principles instead of preaching them, until development is noticed and opportunities present themselves for more intensive efforts in salesmanship.

There has been no attempt in this paper to give an exhaustive treatise on the human element, as the subject is much too broad for even one phase of it to be covered completely in this manner, but the aim has been only to outline a few points, with the hope that thought may be stimulated toward the possibilities of utilizing more of a man than is usually exhibited on the surface while he is on the job. In the undercurrent of a man's thoughts are emotions which, if aroused, will release energy tenfold greater than that usually exhibited. To bring this additional capacity to the point of expression requires an awakening on his part to the personal gain to be derived from doing so. Personal contact is productive of results in bringing this about, and opportunity lies at the feet of the foreman, with his keymen as part of the scheme for accomplishing it.

APPLICATION OF RESEARCH

Of course, intuition has its value and, when guided by adequate knowledge, constitutes the distinction between a class A and a class B mind. "We are poets" was the claim made at a mathematical congress many years ago, and it is the artistic faculty of recognizing and selecting among almost innumerable data those of prime significance that constitutes the distinction between the scientific thinker and the mere "researcher" who does the hodman's work of recording observations and measurements. Indeed, some of those who have made really serious contributions to the advance of scientific thought have not themselves been anything exceptional as either observers or experimentalists, and the converse also holds. Many instances could be adduced in support of this contention, and it is in fact generally recognized that many more men are fitted to contribute to scientific data than to advance scientific thought.

The great engineer and the great organizer must also be gifted with intuition. It is they who have to bridge the gap between a laboratory experiment and its practical applications. The gulf between the two is vast and, to free it, other qualities than mere mental acuteness are demanded, of which perhaps the most conspicuous is courage. Pepys tells in his Diary of some acquaintance who ventured and lost £20,000 in trying to improve methods of coal winning, and, to come to more modern times, more than one fortune was lost in practicalizing the ammonia-soda process before success was finally attained. This instance is in itself sufficient to show the lack of foundation for the statement of a well-known Oxford professor to the effect that a chemist might write on a half sheet of note-paper a formula that would keep a whole community in affluence. Neither carbonate of soda nor sulphuric acid can, however, be produced by a mere paper formula, any more than a steam turbine can be constructed by hitching a table of the properties of steam to a prime-motion shaft. Both the formula and the table may be of great potential value, but actually to realize this, much has to be risked and, in general, much lost before final success is achieved.—*Engineering.*

Factors Governing "Out-of-Roundness" Measurement

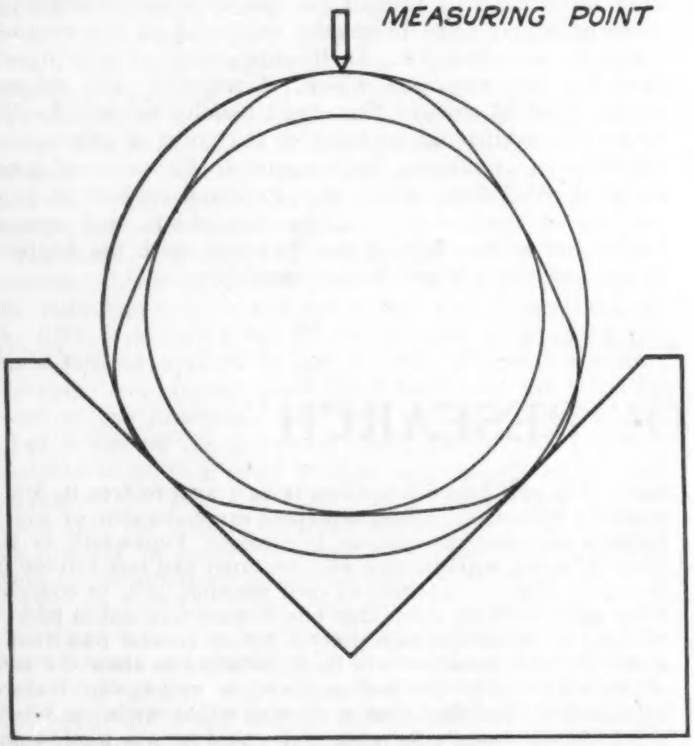
By A. H. Frauenthal[1]

Production Meeting Paper *Illustrated with* **Drawings**

IT is stated that an out-of-round surface having an even number of high-spots requires a checking instrument that has opposed measuring points; and that, if the number of high-spots on the surface is uneven, an instrument having three-point contact, and one of the points of contact located on the center line between the other two, is necessary. Concerning the use of the three-point method, for close work, the angle between the three points of contact must be selected according to the number of high-spots.

Divisions of the subject include types of out-of-roundness and those peculiar to certain machines, the three-point measuring system, errors of the V-block method, use of the V-block for elliptical objects, other methods of checking elliptical forms and indicator-reading correction. Three items for instrument improvement are suggested to manufacturers.

ACCURATE measurement of "out-of-roundness" is an important item of inspection that, it seems, has not received due consideration even in our larger plants which use the most modern of measuring instruments. It is an item that affects quantity, quality and cost of production. If, through a fallacy of inspection methods, parts are produced and accepted for production that exceed the specified limits, there is generally a falling-off of production due to the difficulty of assembling parts in this condition, and the quality certainly is lowered through the loss of bearing area. On the other hand, if parts that are actually within the specified limits are rejected and scrapped, the decrease in quantity of production and the increase in cost of production are obvious.



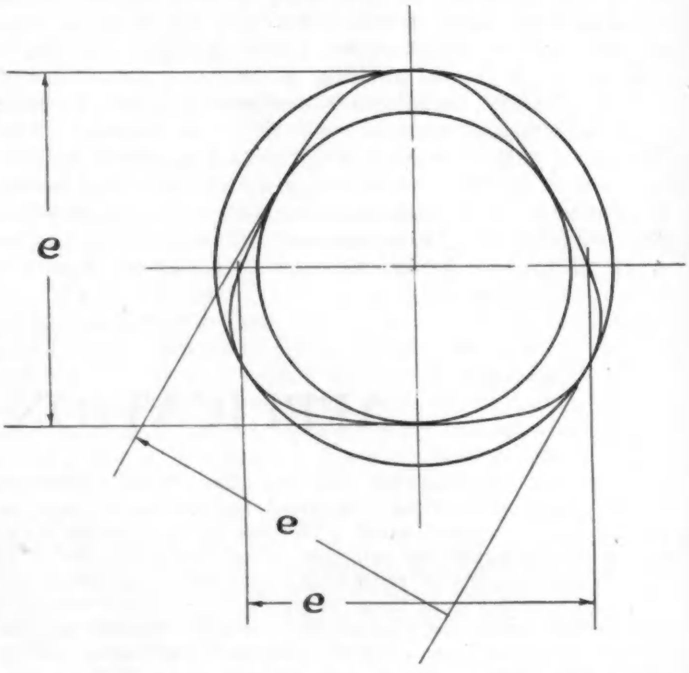


Fig. 1—Drawings Showing a Cylindrical Object, the Out-of-Roundness of Which Is Greatly Exaggerated

Types of Out-of-Roundness

The two different general types of out-of-roundness are "regular" and "irregular."

The irregular class comprises those objects which assume an irregular shape and, consequently, will not be governed by any set rules for their inspection. Under this head are parts that become out-of-round due to distortion in heat-treatment, crowding of tools by hard spots, and the like.

The regular class is composed of those objects the high and the low-spots of which manifest some mathematical continuity. Since the objects do contain high-spots and low-spots, their sections are no longer circles and must not be treated as such. If the object contains two diametrically opposite high-spots and two diametrically opposite low-spots, its section is an ellipse; and, if it contains a greater number of high-spots and low-spots and we consider the low-spots as sides and the high-spots as vertices, the section becomes either a triangle, a square or some other polygon. The paper deals with this latter class of out-of-roundness.

Automobile parts, such as piston-pins, small shafts,

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valve-lifters, shackle-bolts, roller-bearing pins and many other similar parts, are generally ground on centerless grinders. It has been determined that, on work that comes out-of-round from a centerless grinder, that the quality of high-spots and low-spots is always a number that is a multiple of 3. This condition is, no doubt, due to the fact that the centerless grinder has three points of pressure on the part being ground; namely, the grinding wheel, the feed wheel and the work support. On the other hand the number of high-spots and low-spots on work that comes out-of-round from the ordinary grinder employing centers generally is a multiple of 2. This is doubtless due to the two points of pressure on the piece being ground; namely, the centers and the grinding wheel.

Other machines also produce out-of-round work, particularly gear-driven machinery on which the number of high-spots or low-spots is equal to a multiple or factor of the number of teeth in one of the gears or the train of gears. Due to the varied shapes which an out-of-round piece may take, it is necessary to use different types of checking apparatus to determine the true conditions of each differently shaped piece.

The Three-Point Measuring-System

Fig. 1 shows a cylindrical object the out-of-roundness of which is greatly exaggerated. This is shown in the shape of a triangle and is the empirical form in which out-of-roundness manifests itself from the centerless grinder. It can be seen readily that if a checking method employing directly opposed measuring points were used on a piece of this shape, it might appear absolutely round; whereas, it actually could be considerably out-of-round. This is due to the fact that one of the measuring points would be located on a low point, while the one directly opposite it would be located on a high point, and this condition would persist while the entire periphery of the object was revolved through the measuring points. Since the actual amount of out-of-roundness of any piece is the difference in the diameters of the inscribed and circumscribed circles, it is necessary to use a measuring apparatus that registers in three places in the case of triangular objects.

Various three-point measuring-tools are on the market and, since their application and results are all approximately the same, we may use for an example the V-block method as employed with any of the numerous amplifying gages, such as the one shown in Fig. 2. The amplifying gage is merely an apparatus that employs a lever

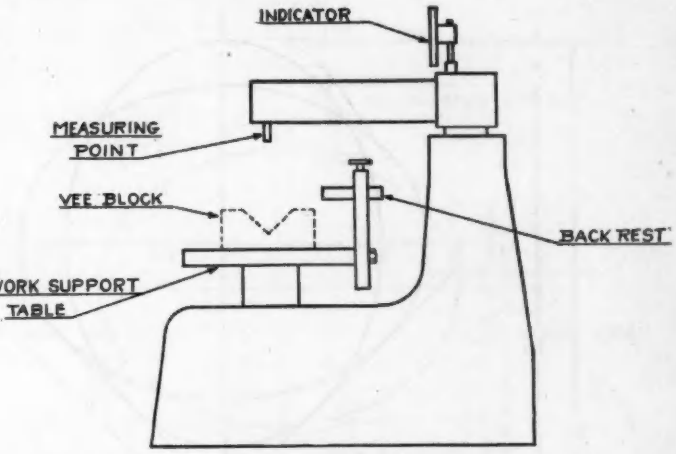


Fig. 2—Amplifying Gage Used with the V-Block To Measure Out-of-Roundness

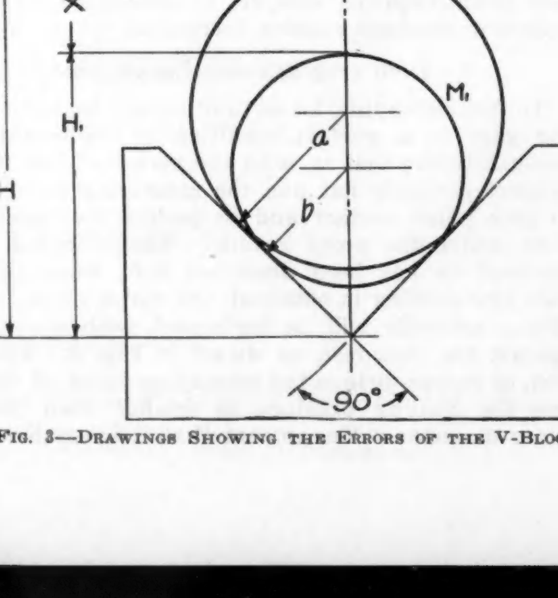
system to increase the movement of a measuring point held in contact with the work, and an indicator to measure the increased movement. While there are various different gages on the market, the principle of all is the same and with most of them are furnished different types of work supports, such as centers, V-blocks or flat plates.

Errors of the V-Block Method

To the casual observer, this method may appear to give accurate results but such is actually not the case and, for each different included angle of the V, a different correction must be applied to the indicator reading. This correction is obtained by very simple mathematics and we will demonstrate the necessary correction on a V-block having a 90-deg. included-angle, since this is the angle universally accepted for commercial V-blocks.

It would be incorrect to use a 90-deg.-angle V-block for a piece containing three high-spots, since the high-spots would be indexed 120 deg. from each other, thus requiring a V-block having a 120-deg. included-angle. This is merely an empirical example of how the correction is obtained; it is, therefore, permissible, and the correction obtained can be used when inspecting diametrical variations on parts within the tolerance for out-of-roundness.

Inasmuch as the V-block method will, at some time or other, while the piece is being revolved, present the inscribed circle to the three registering points and, at some other time, present the circumscribed circle to the three



$D = 2a$

$D_1 = 2b$

$H = a + \sqrt{2a^2}$

$H_1 = b + \sqrt{2b^2}$

$X = (a + \sqrt{2a^2}) - (b + \sqrt{2b^2})$

$2X = (D + \sqrt{2D^2}) - (D_1 + \sqrt{2D_1^2})$

$X = 1.2071\,(D - D_1)$

DIFFERENCE IN READINGS AT M AND M1 WILL BE 1.2071 TIMES ACTUAL DIFFERENCE IN DIAMETERS, I.E. THERE WILL BE AN EXAGGERATION OF APPROXIMATLY 21%.

Fig. 3—Drawings Showing the Errors of the V-Block Method and the Method of Working Out the Correction

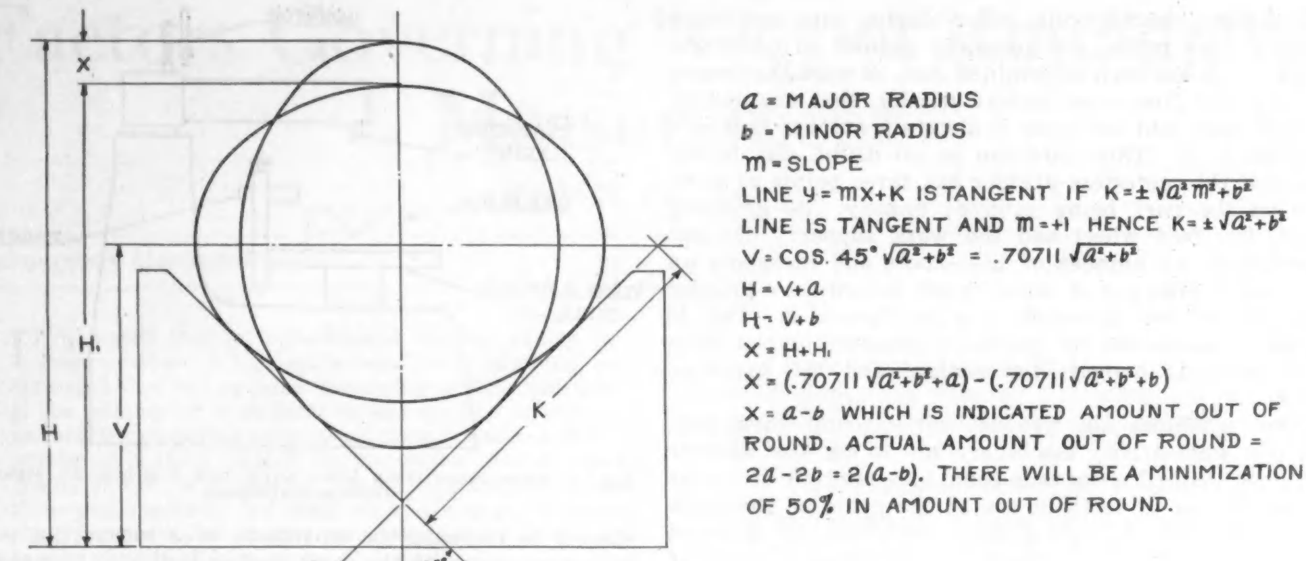


FIG. 4—CHECKING AN ELLIPTICAL OBJECT WITH A V-BLOCK

registering points, we can use any two circles of selected diameter and find out how much higher one will set in the V-block than the other. This figure, minus the actual difference in diameters, is the amount of the correction. Fig. 3 shows the conditions with the correction worked-out; it is approximately 21 per cent.

ELLIPTICAL OBJECTS IN A V-BLOCK

The V-block method already described often is used erroneously on work for which the character of out-of-roundness has not been determined previously. The results gained from using this method with elliptical objects are shown in Fig. 4.

With reference to Fig. 4, we would be unable to register on the major or the minor peripheries and, as the major axis while in the lowest position would coincide with the minor axis, while in the highest position, the indicated amount of out-of-roundness would be the difference in the major and the minor radii. Since the actual amount of out-of-roundness equals the difference in the major and the minor diameters, the error is 50 per cent.

OTHER METHODS FOR CHECKING ELLIPTICAL FORMS

Fig. 5 shows a cylinder with the out-of-roundness in the elliptical form and exaggerated greatly. Inasmuch as the amount of out-of-roundness of any object is the difference in the diameters of the inscribed and circumscribed circles, it would be a very easy matter to measure this difference on the part shown merely by applying some measuring instrument with opposed measuring points, such as the micrometer caliper, to the distances a and b.

However, the micrometer caliper is no longer used for quantity inspection of work of this type, and has been replaced by the amplifying gage. The reasons for this are familiar to all, or are very obvious at least, and do not require discussion here.

In a manner analogous to that of the micrometer, the piece could be moved back and forth, horizontally, under the measuring point, until the highest and the lowest readings were obtained. This is a very accurate method, but is, unfortunately, slow. To overcome the difficulty of finding the highest and the lowest points and to eliminate the horizontal motion, which requires considerable time, the back-rest has been added as shown. When using this appliance, the original indicator-setting is made by a pluggage or master-piece which is moved back and forth under the measuring point until the highest reading is obtained.

The position of highest reading is, of course, at the diameter of the circle and, with this obtained, the back-rest is moved-up to the master-piece and fastened in place. In the actual inspection, the piece being tested is held firmly against the back-rest and revolved under the measuring point. This method is very rapid; however, it adds a third measuring-point to the combination and hence requires analysis to determine whether the indicator readings require correction.

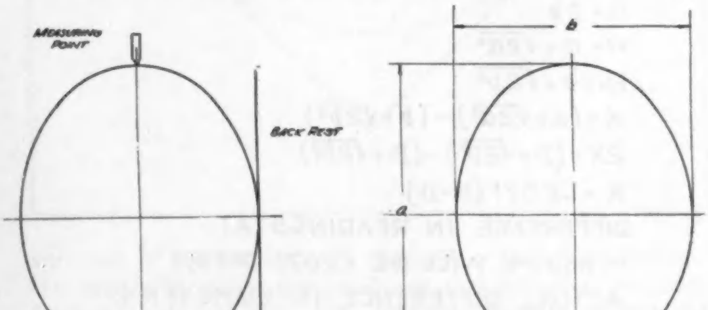


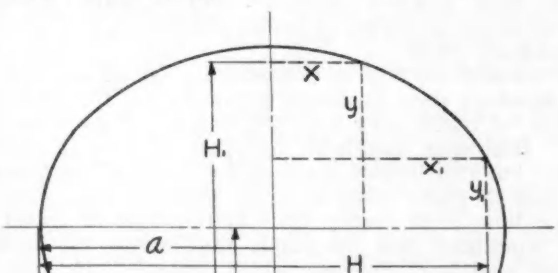
FIG. 5—CHECKING OUT-OF-ROUNDNESS WITH MICROMETER CALIPERS

INDICATOR-READING CORRECTION

To determine this, let us first assume that the amplifying gage is in perfect condition as received from the manufacturer; that is, with the back-rest and the work-support perfectly flat and the measuring point rounded to give point contact and to permit the specimens to slide under the point readily. The elliptical piece is revolved as has been described and, when the lowest indicator-reading is obtained, the major diameter of the ellipse naturally will be horizontal, with one extremity against the back-rest, as shown in Fig. 6. This condition, of course, brings the measuring point off the center and the reading obtained is smaller than the actual minor-diameter. The amount that it is smaller depends

on two quantities, the actual amount of out-of-roundness, which is unknown, and the degree of curvature of the measuring point.

When the highest indicator-reading is obtained, the conditions are just the same in effect, a smaller reading than the major diameter is obtained, and the amount that it is smaller depends on the same conditions. Although, with a perfect ellipse, the measuring point is the same amount off-center when taking the highest reading as it is when taking the lowest reading, the difference in readings, which is the indicated amount of out-of-roundness, is not exactly the actual amount of out-of-roundness, even though we were able to procure point contact at the measuring point, which would eliminate the complication of the radius. It is, however, so nearly the correct amount that the method would be perfectly safe to use, even on so close a job as piston-pins, if it were possible to obtain the perfect conditions just described. However, it must be remembered that all readings, whether used in checking roundness or size variations, will be complicated by the radius on the measuring point. To overcome this condition, trials should be made periodically with known-diameter master-pieces to obtain corrections for radius and wear of the measuring-point radius.



a = MAJOR RADIUS

b = MINOR RADIUS

$\therefore \frac{a-b}{2}$ = AMOUNT MEASURING POINT IS OFF CENTER

$\frac{x^2}{a^2}+\frac{y^2}{b^2}=1$ (EQUATION OF ELLIPSE)

$X=\frac{a-b}{2}$

$y=\frac{\pm b}{2a}\sqrt{3a^2+2ab-b^2}$

$H_1=b+y$

$H_1=b+\frac{b}{2a}\sqrt{3a^2+2ab-b^2}$

$\frac{x_1^2}{a^2}+\frac{y_1^2}{b^2}=1$ EQUATION OF ELLIPSE

$y_1=\frac{a-b}{2}$

$X_1=\frac{\pm a}{2b}\sqrt{3b^2+2ba-a^2}$

$H=a+X_1$

$H=a+\frac{a}{2b}\sqrt{3b^2+2ba-a^2}$

$H-H=a-b\pm\frac{a}{2b}\sqrt{3a^2+2ab-b^2}\pm\frac{b}{2a}\sqrt{3b^2+2ba-a^2}$

FIG. 6—DRAWING SHOWING HOW THE AMOUNT OF ERROR IN AN ELLIPTICAL OBJECT IS DETERMINED

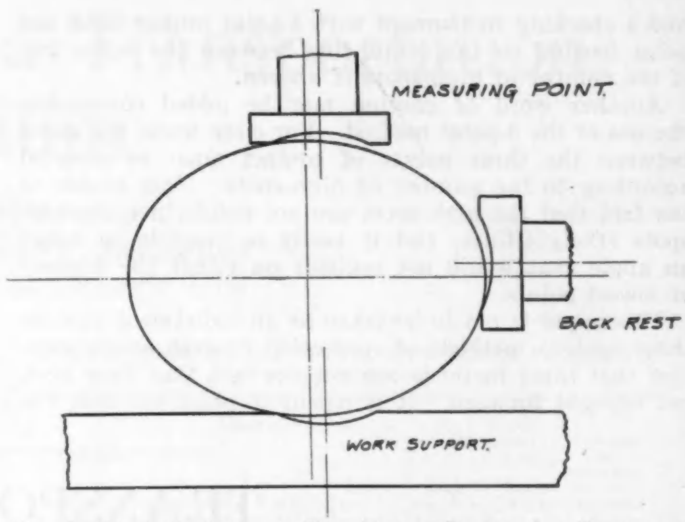


FIG. 7—DRAWING SHOWING HOW ERRORS OCCUR AS A RESULT OF WEAR OF THE MEASURING POINTS

Fig. 6 shows the amount of error in the reading of both the highest and the lowest points and, although this particular error is very large, their difference in readings is very close to the actual amount the specimen is out-of-round. Unfortunately, the formula for the corrections comes out in an involved form that does not permit us to show the percentage of error readily. However, the correction necessary, due to the complications of the radius on the measuring point, is greater than the foregoing correction.

Now let us suppose that the instrument is not absolutely new but has seen enough service to show some slight wear on the three registering points; the support-plate, the back-rest and the measuring point. After 2000 pieces are measured on one of these machines, the wear is evident even though the points subjected to wear show a scleroscope hardness as high as 90. This is a natural condition, as the pressure is very concentrated due to the bearing at all three points being a point of tangency.

The conditions shown in Fig. 7 now take place. With the major-diameter horizontal, the point of contact with the back-rest is either off the lowest point on the edge of, or entirely outside, the worn groove; this results in a lower reading than the true reading, due to the abnormal amount the measuring point is off-center. On the work-support, the piece is again either off the lowest point on the edge of, or entirely out of, the worn groove; this results also in a higher reading than the true reading, and the same condition is true at the measuring point. Hence, we see that one worn point contributes to a lower reading, while the two other worn points contribute to a higher reading. With the specimen in position with the major-diameter vertical, the results obtained are similar. The amount of error in the indicator-readings depends again on two quantities: the amount of out-of-round and the amount of wear. Inasmuch as the former quantity is unknown and the latter quality unknown or at least varying constantly, the results obtained cannot be corrected by any set mathematical formula and the correction must be obtained by checking with known-diameter master-pieces in the manner described.

CONCLUSION

This discussion demonstrates that an out-of-round surface requires a checking instrument having opposed measuring-points if the number of high-spots is even

and a checking instrument with 3-point contact with one point located on the center-line between the other two if the number of high-spots is uneven.

Another word of caution may be added concerning the use of the 3-point method. For close work, the angle between the three points of contact must be selected according to the number of high-spots. This is due to the fact that the high-spots are not points, nor the low-spots straight-lines, and it easily is possible to select an angle that would not register on either the highest or lowest points.

This paper is not to be taken as an indictment against these various methods of inspection or even an implication that these methods are not the best that have been yet brought forward. It is meant to point out that the various indicator-readings require correction to produce correct results. It was also intended to bring out the fact that there is still considerable room for improvement of these instruments to eliminate some of our present difficulties. In connection with this, I suggest three items that probably are worthy of consideration by the manufacturers:

(1) A flat measuring-point large enough to reach the major diameter when it is off-center with the measuring point due to ellipticity
(2) A revolving characteristic of the measuring point to promote even wear
(3) A corrected indicator for use with the 90-deg.-angle V-block, thus eliminating correction by the operator

TRANSPORTATION

NO country in the world has the possibilities for efficient, modern transportation which we have. We must realize upon those possibilities. Our one great difficulty has been that we have grown at such an astonishing rate that our facilities have lagged far behind. Thus, in the motor field, while from 1910 to 1922 there has been an increase of 2450 per cent in the number of vehicles, and a far greater increase in mileage traveled and tonnage hauled, all of our efforts have failed to provide an adequate increase in our roadbed facilities in the same period, and at our present rate it will be 10 years before the United States can hope to arrive at a rounded-out highway system.

While freight cars have been increased in number by 23 per cent in the last 10 years, and the aggregate tractive power of locomotives 41 per cent, the Country is offering the railroads 60 per cent more business than ever before. Since the whole structure of business activity rests upon transportation, it is evident that we must use those facilities which we have in the most efficient way, unless the Country is to suffer from tremendous losses.

The actual competition between rail and motor carriers today is negligible and where it does exist it is largely due to the fact that the rail lines, suffering from undue regulation and cramped beyond reason financially, have been unable to provide desired facilities.

Responsible railroad executives have said that 25 per cent of railroad equipment is absorbed in the haulage of less than 5 per cent of the commodity movement and that it returns but about 10 per cent of the revenue. This is the less-than-carload movement in which is involved most of the terminal troubles to which the railroad men of the present generation have fallen heir. Terminal facilities, taken to mean all other than main line facilities, another authority has said, represent about 50 per cent of the total capital investment of the rail lines.

The operation of the truck makes possible new extensions of the field of our waterways. One of these is the vehicle used as a flexible medium of interchange between water and rail-heads. Another is the development of a pick-up and distribution service tying industrial and agricultural areas to inland and coastal shipping points.

While we now have some 350,000 miles of improved highway, 259,000 miles of railroad, 18,000 miles of interurban electric lines and 15,000 miles of inland canals and waterways, none of the older forms of transport can reap the full benefit from highway transport until a much larger percentage of our 2,800,000 odd miles of highway is made ready for constant traffic.

Government surveys in Connecticut, Tennessee, Maryland, and elsewhere show conclusively that by far the largest percentage of traffic even over our main highways is purely local. Highways, paralleled by other carriers in many instances but still largely destined for "feeder" uses, must be improved in every State in order that the rail, water and electric lines shall realize their full volume of travel; and more important, that the public shall derive the benefit of lowered transport charges which logically and naturally follow improved highways.

A study made from government figures by John E. Walker, formerly tax advisor to the Treasury, shows that the rail lines contributed approximately \$304,000,000 in taxes in 1922. Motor users paid special taxes of \$340,000,000 in 1922, or the equivalent of nearly one-half of the total highway construction and maintenance bill of the Nation, estimated at \$742,000,000. Of that amount, \$120,000,000 were discriminatory taxes levied by the Federal government and exactly comparable to those railroad taxes which, also growing out of the war, were repealed by a recent session of Congress.

The user should pay a fair charge for service rendered. But those taxes which are levied for construction or which do not go into highway work at all constitute the payment of general benefits through special levies which add materially to the cost to the public of this form of transportation.

Other large taxes are assessed against the electric lines and other carriers, yet inevitably the consumer must pay. In all these cases, then, we have an artificial barrier imposed in the way of efficient transportation at the lowest cost to the using public.—From an address by Roy D. Chapin before the Chamber of Commerce of the United States.

MOTORSHIPS

THE one outstanding feature of new orders for British shipbuilding placed during the past 6 months is the growing share of motorships in the total tonnage booked. It might almost be said that the demand for motorships has recently been the salvation of British yards. The details shown by Lloyd's returns are given in the accompanying table.

In addition to those already laid down, contracts have been made for some large motorboats, on which work has not yet been started.—*Commerce Reports*.

GROSS TONNAGE OF MOTORSHIPS UNDER CONSTRUCTION

	Last Quarter of 1922	First Quarter of 1923	Second Quarter of 1923
Clyde	77,815	76,825	92,380
Belfast	......	19,000	41,000
Tyne	15,200	17,700	32,865
Other Yards	32,335	44,259	55,029
Total	125,350	157,784	221,274

The Motorbus as a Transportation Medium

Discussion at Annual Meeting of American Electric Railway Association Held Last Month at Atlantic City

THE motorbus was probably the most conspicuous feature of the discussions presented and the exhibits made at the 42nd Annual Convention of the American Electric Railway Association and its affiliated bodies held at Atlantic City, N. J., on Oct. 8 to 12. A score or more of companies exhibited complete buses or unit assemblies therefor. Their efforts resulted in the largest and most interesting motorbus show that has ever been held in this Country.

C. D. Emmons, the retiring president of the Association, enlarged upon the fact that the motorbus is finding its place and rendering great service in the solution of the transportation problem. More than 100 electric railways are using approximately 1000 buses. The electric street-railway industry has 44,000 miles of track, employs 300,000 persons directly and furnishes part or whole-time employment to 500,000 more, transports more than 15,000,000,000 persons annually and represents an investment of between $5,000,000,000 and $6,000,000,000.

Alfred Reeves, general manager of the National Automobile Chamber of Commerce, gave an address on the Coordination of Electric-Railway and Bus Transportation. He said that the spirit of the motorbus industry is that of cooperation. He pointed out that low cost of operation is not the sole consideration in bus operation, the public being willing to pay 10-cent fares for service it considers good enough; and expressed the opinion that in general bus lines should be operated by the electric traction interests. In connection with a large portion of the public being accustomed to ride on rubber tires, he spoke of the contest between rubber and the iron rail. He propounded the question, If the bus had come first, would the trolley car have been developed? What the public wants is service and adequate service can be given only through utilization of both the bus and the trolley car. The natural fields of each should be defined as accurately as possible. Mr. Reeves said that the failure of bus lines in various cities is not significant, as the operating companies were organized in undue haste and without proper planning.

As was stated by L. S. Storrs, president of the Connecticut Co., the outstanding feature of the meeting, at least in connection with bus operation, was the conferring of representatives of the street-railway field with those of the automotive field, through their respective organizations. President Alden, of the Society of Automotive Engineers, discussed a report on bus operation that had been prepared by a committee of the American Electric Railway Transportation and Traffic Association, an affiliate of the American Electric Railway Association. It was set forth in this report that public authorities are gradually bringing order out of the chaotic condition which the jitney introduced into the transportation field 7 or 8 years ago. The committee presented data on bus operation that had been secured from street-railway companies. It was stated that the experience of these companies had been comparatively short and that none of them desired to go on record as being confident of having solved the various problems involved. The report was completed prior to July of this year.

The committee obtained information as to the class of service operated from 17 street-railway companies. To establish a relation between the class and the amount of service and the data that follow for each company, Table 1 was compiled.

Seven of these companies operate exclusively on city routes. Four companies operate exclusively in suburban service; two exclusively in interurban service, two in city and suburban service, one in city and interurban service and one in city, suburban and interurban service.

TABLE 1—DATA ON BUS SERVICE OPERATED BY 17 STREET-RAILWAY COMPANIES

Company	Class of Service			No of Buses Operated		Average Daily Mileage per Bus Operated
	Supplementary	Feeder	Independent	Base Schedule	Peak Schedule	
A	....	Yes	....	2	3	100
B	Yes	Yes	....	1	1	153
C	Yes	Yes	....	21	27	81
D	....	Yes	....	6	7	148
E	....	....	Yes	1	1	185
F	....	Yes	....	5	8	70
H	....	Yes	Yes	16	21	120
I	Yes	Yes	....	18	8	161
K	Yes	Yes	Yes	7	10	151
L	....	Yes	....	2	3	74
M	....	....	Yes	4	7	145
N	....	....	Yes	5	7	127
O	....	....	Yes	6	7	96
P	Yes	Yes	Yes	66	70	166
Q	Yes	....	....	6	10	216
R	....	....	Yes	12	16	153
S	Yes	Yes	Yes	9	9	....

Among the reasons given by the railway companies for the inauguration of bus service were the following:

> We were compelled by prohibitive cost of new paving and track work to substitute bus service for trolley service on two feeder-lines.
>
> To give residents of one city better service to another via a shorter route and provide service to people residing and working between the two towns.
>
> Our company was confronted with serious competition from buses and we inaugurated our original bus-line to determine what the possibilities of bus service were and also to protect ourselves against unwarranted and unregulated competition. As a result of the operation for a period of over 7 years, we have built up a service that is paying its way under present rates of fare and providing transportation to a district that needs and appreciates it.
>
> We have considered that with the right to a monopoly of transportation went the obligation to furnish reasonable and adequate transportation facilities wherever they were needed, and the obligation to use whatever motive power was best adapted to the conditions.
>
> Stage-line service was inaugurated to make possible through service between two cities, a route mileage of approximately 100 miles, by which the work of carrying passengers could be done with motor stages with a much smaller investment than by rail.
>
> The physical situation of the line prevented the giving of a street-railway service that was rapid enough to suit those whose necessity or convenience required quick transportation between the towns served. In effect the coach transportation is a limited street-railway service supplementing the slower service given by street cars regularly. However, the coaches probably afford a more pleasant ride and through the advance sale of reserved seats, it is very convenient for prospective passengers to avail themselves of this service.

The committee reported that if a street-railway company adopts the policy of providing for all of the transportation needs in the territory served, the possibilities of the bus as an aid to the carrying out of such a policy cannot be overlooked. As to the matter of substituting bus for rail service, this is wholly a problem in economics. In the case of a low-earning rail-line faced with heavy rehabilitation or paving charges, the bus provides a means of continuing service at an expenditure for equipment that is much below the cost of plant renewals or paving.

The committee expressed gratification that street-railway companies are discarding the truck chassis and adopting the improved types as rapidly as the builders are developing them; and stated that, in the further development of the chassis, simplicity and accessibility should be the chief aim of automotive engineers. It should be borne in mind that ordinary running repairs are made without removing the body and, therefore, easy removal and replacement of parts from underneath the chassis should be made possible. It is very desirable that time out of service be the minimum. A unit repair-system will meet this requirement best. To facilitate this, attention should be given to standardization.

Consideration must be given also to the peculiar requirements of a vehicle operated in passenger service, such as a low center of gravity, clutch and gear designs that are suitable for frequent stopping and starting, adequate and economical power and spring-suspension to give the maximum riding-comfort under varying load conditions.

The report did not cover body development in any detail as the committee believes that each operating company will work out its own requirements in this connection. In general, the committee felt that no reason exists why the electric-car body designs cannot be used as a base from which to develop bus bodies that will give public satisfaction from the standpoints of safety, comfort and convenience. There will, of course, always be cases that will require specific treatment based on the particular transportation problem to be solved.

The majority of the bus-lines reported on were operated by the organizations that manage the respective street-car systems. In general, the buses were maintained by the railway companies, specially skilled mechanics being employed for work on the buses, which it is appreciated are an essentially different type of equipment.

Most of the street-railway companies are operating buses on such a small scale that in the committee's opinion the companies would not be warranted in incurring the increased overhead and maintenance costs that would be necessary if their bus work were separated entirely from the electric-car work. However, this practice ceases to yield the maximum efficiency and economy the moment the number of units becomes large enough to justify keeping a separate corps of mechanics, inspectors and cleaners busy during the entire working-day. Bus-chassis maintenance requires an entirely different kind of training than electric-car maintenance, and if an attempt is made to spread the supervision of maintenance over both types of equipment, the maintenance of both will be unsatisfactory. Owing to the wide diversity of local conditions, the committee was unable to suggest a standard maintenance organization. The observation was made, however, that, inasmuch as bus bodies are now following very closely the type of construction used in electric-car bodies, body maintenance can be conducted most efficiently and economically by supplementing the regular body-maintenance force. Several of the railway companies have constructed or plan to construct separate bus garages.

In the majority of the cases the rates of fare for the street-car lines apply to the buses operated by the traction companies. Transfers are usually issued.

Depreciation

Among the bases for allowing for depreciation of the buses were

100,000 to 200,000 miles of travel
3-year life
20-per cent depreciation; straight-line method
4-year life; most of the buses will last longer than 4 years with present maintenance standards, but it is believed improvements in bus design will render present buses obsolete within 4 years
25-per cent depreciation
Estimated life of chassis up to 2-ton, 150,000 miles; 2-ton and over, 200,000 miles
5-year basis
3-year basis; 1/12 of 33 per cent of book value, less $500 salvage value, charged-off per vehicle per month
Salvage value of 20 per cent of original cost at end of 3 years; 80 per cent charged off in 3 years
10 per cent of original cost taken as salvage value; balance of 90 per cent charged off in 6 years
80 per cent of original cost charged off in 3 years
25 per cent per year; buses average 60,000 miles per year
5-year life, 5-per cent salvage, 19 per cent per year depreciation

None of the companies was in a position to give definite information as to the life of bus equipment. All of the depreciation methods are still in the tentative stage. The committee felt that as the life of tires is relatively short the cost of them should not be included in the principal amount to be depreciated; and that, because of the many variable factors involved in the physical depreciation or wear-and-tear of a bus, it is difficult to formulate standard practice for charging depreciation in this connection. In a new art, of course, consideration must be given in calculating depreciation charges to obsolescence and inadequacy.

The committee reported that with one exception the information received indicated that the public is entirely in favor of bus operation by the street-railway companies.

Operating Costs

With regard to the table of cost of operation submitted by the committee and reproduced as Table 2, it was stated that this presented the results of such limited experience by all of the companies that it did not indicate clearly what should be expected in the future. None of the companies has been operating much longer than 1 year. Their equipment was new and did not require heavy expenditures for repairs or renewals for some months. The equipment consisted of chassis of from ¾ to 2½-ton carrying and of from 12 to 25 seating capacity, the total weight of the buses varying from 3000 to 10,000 lb. Most of the tire equipment was of the pneumatic type.

The committee said that, on account of the lesser seating-capacity of the bus, the cost per passenger is considerably higher than in electric-car operation. The average cost per bus-mile, incuding taxes and estimated depreciation, based on the figures furnished to the committee, is 24.6 cents. No results from the operation of double-deck buses were included in the compilation and it was assumed that the average seating-capacity per bus was 25. On this basis the cost per seat-mile of bus operation was 0.98 cent. Data obtained from 10 companies operating one-man trolley cars showed an average cost per car-mile of 25.7 cents, including depreciation based on the estimated life of the equipment and taxes. These cars had an average seating capacity of 42, and the resulting cost per seat-mile was 0.61 cents. On this basis the cost per seat-mile of bus operation is approximately 60 per cent greater than in the case of the one-man electric car. The figures did not, however, include a return on the value of the property.

The committee referred to the fact that in some localities the law prevents the carrying in buses of few if any more passengers than seats are provided for. In this respect the street-car is more elastic. In general, three buses are required to furnish the same number of seats as two trolley cars.

The committee of the Transportation and Traffic Association that made the report referred to above was constituted of, among others, representatives of the following companies:

TABLE 2—OPERATING RESULTS PER BUS-MILE REPORTED BY STREET-RAILWAY COMMITTEE

Company	*A*	*B*	*C*	*D*	*E*	*H*	*I*	*L*	*K*	*O*	*O*	*R*	
	1-1-23 to 5-31-23	1-1-22 to 3-31-23	7-1-22 to 3-31-23	5-26-22 to 3-31-23	1-1-22 to 3-31-23	3-1-22 to 3-31-23	1-1-22 to 3-31-23	12-1-21 to 11-30-22	7-3-22 to 3-31-23	7-15-22 to 12-31-22	1-1-22 to 12-31-22	4-1-22 to 3-31-23	Weighted Average of All Companies
	Cents	Cents	Cents	Cents	Cents	Cents	Cents	Cents	Cents	Cents	Cents	Cents	Cents
Transportation Revenue	26.50	21.18	28.67	13.42	25.99	25.25	19.23	6.11	20.84	29.79	17.41	26.28	21.18
Other Revenue	....	....	0.60	0.04	....	0.02	0.06	....	0.04	0.86	0.51	....	0.21
Total Revenue	26.50	21.18	29.27	13.46	25.99	25.27	19.29	6.11	20.88	30.65	17.92	26.28	21.39
Maintenance, Excluding Depreciation and Tires	3.83	1.95	4.50	1.62	3.02	6.56	4.00	2.62	5.42	6.71	2.97	2.61	4.20
Tires	1.50	1.94	1.49	1.32	0.85	2.48	2.43	1.87	1.65	2.50	1.51	0.47	1.88
Depreciation	3.00	2.68	3.88	3.25	2.29	3.96	2.67	7.19	3.05	2.87	2.68	1.03	3.08
Wages of Bus Operators	7.68	5.65	6.49	6.09	7.03	6.91	6.05	6.43	5.64	4.55	3.82	6.04	5.74
Other Conducting Transportation Expenses	4.83	3.26	10.19	5.84	7.18	7.67	5.06	4.60	7.01	3.33	3.29	7.21	5.95
Injuries and Damages, Insurance, Other General Expenses	3.25	2.52	3.44	0.77	6.56	3.04	3.93	0.57	0.74	5.32	3.64	2.56	3.10
Total Expense	24.09	18.00	29.99	18.89	26.93	30.62	24.14	23.28	23.51	25.28	17.91	19.92	23.95
Net Operating Revenue[1]	2.41	3.18	*0.72*	*5.43*	*0.94*	*5.35*	*4.85*	*17.17*	*2.63*	5.37	0.01	6.36	*2.56*
Taxes	0.92	0.25	2.10	0.60	0.15	0.24	0.92	0.65	0.05	0.18	0.40	0.49	0.65
Operating Income[1]	1.49	2.93	*2.82*	*6.03*	*1.09*	*5.59*	*5.77*	*17.82*	*2.68*	5.19	*0.39*	5.87	*3.21*
Operating Ratio	90	85	102	140	104	121	125	381	113	82	100	76	112
Bus-Miles	35,124	70,371	443,602	226,798	80,596	653,249	1,126,189	108,017	479,303	144,605	806,354	234,107	4,373,191 (*a*)

[1]Deficits are shown in italics.
(*a*) Total for all companies.

United Electric Railways Co., Washington Railway & Electric Co. (City of Washington), Pennsylvania & Ohio Traction Co., Milwaukee Electric Railway & Light Co., United Railways & Electric Co. of Baltimore, Connecticut Co., Virginia Railway & Power Co. and Boston Elevated Railway Co.

President Alden's Discussion

After expressing appreciation of the opportunity to participate in the meeting as a representative of the Society of Automotive Engineers, President Alden said:

We were honored by the presence of President Emmons, of the American Electric Railway Association, at the Cleveland meeting of the Society of Automotive Engineers last spring. Our two organizations should work hand-in-hand in solving the problems presented by the new form of transportation under discussion today. It is none too early for the designer and the builder to get together with the user. Only by sincere and hearty cooperation can satisfactory progress be made. Plain speaking on both sides, if of a constructive nature, should be welcomed by both sides. Destructive criticism by either party will not only be a waste of time, but impede cooperation; and cooperation is the keynote of success. I feel that at this, our first official appearance with you, we should not be too argumentative. It is of far more importance to the success of this young project that we get together, as we are doing now; try to understand each others' viewpoints more clearly; approach the problem in a cordial spirit of give-and-take; and assume that the other fellow knows his own problems pretty well. Then we can be of the greatest mutual assistance.

I shall not discuss at length the advantages of bus transportation or try to prove that it is the last word in passenger transportation. All new things remain if they fill a need and only insofar as they do fill a need. We could get up no argument on the fact that present-day railroad and street-railway transportation do not meet all passenger-transportation needs. The activity of your association, as evidenced by the report under discussion, proves this. A need for motorbus transportation exists. The problem is to define that need and find means to meet it.

Your committee is to be congratulated on the breadth and scope of its investigation. This should furnish an excellent foundation for future endeavor. My remarks will be confined largely to the subject of that report.

Judging from the phenomenal growth of motorbus transportation, in both city and inter-city work, it is obvious that the motorbus does fill a certain need in the life of the Nation. Here and there it will be overdone. At times it will be foolishly handled. Out of all, however, will gradually emerge a new form of passenger transportation, giving a service the street-railway never can give. It will create its own traffic in many places, because of its unique characteristics. In the last analysis, however, it will remain only when and where it can make money for the operator. This is the final test. It must be a revenue producer.

I wish to give credit for great assistance in preparing these notes to the publishers of *Bus Transportation*, G. A. Green, of the Yellow Coach Co., Chicago, and F. C. Horner, of the General Motors Corporation. Your attention is directed to a paper[2] presented by W. P. Kennedy before the Metropolitan Section of the Society of Automotive Engineers on the subject of trolley buses and to the discussion[3] of this paper, which was published in THE JOURNAL recently. In both the paper and the discussion much valuable information will be found.

Proceeding now to the report proper, the first thing that struck me was that the companies investigated were all street-railway companies. I can understand readily that to make as complete an investigation of the operations of outside or independent companies might be very difficult, as well as contrary to the policy of your association. It seems, however, that the picture presented by the report would have been somewhat different if independent companies had been canvassed, because a great many independent bus-companies are making money.

The general summary of the results reported by your 12 company-members shows a net loss. We should not jump to the conclusion that this is a chronic and expected condition. Your report shows that 4 out of the 12 companies received revenue in excess of expenses. Two of the 12 had such ridiculously low revenues that it seems that they tried to operate under impossible conditions. It appears to us that your association ought to extend its official investigations to independent companies. It is realized, of course, that the

[2] See THE JOURNAL, September, 1923, p. 179.
[3] See THE JOURNAL, October, 1923, p. 322.

conditions under which many independent companies operate are free from some of the handicaps with which the street-railway companies are saddled. On the other hand, I have always been a firm believer in trying to get a pretty clear idea of what the other fellow is doing and making it a matter of permanent record.

The committee investigation covered only single-deck buses. In many places a double-deck bus is suitable, as evidenced by its success in London, New York City, Chicago and Detroit, in all of which cities revenues exceed expense by a comfortable margin.

It is gratifying that, in spite of the rather gloomy picture painted, the consensus of opinion among your operators seems to be that the motorbus is here to stay. The early years in any undertaking are generally painful. They appear to be so in this case. However, I am informed that in 1921 composite results of 52 city railways showed 46.5 cents per mile revenue and 45.7 cents per mile expense. This is not a particularly rosy picture either.

In analyzing the reasons cited by the companies investigated as to why motorbus transportation was taken up, considerable light is thrown on the subject. These reasons can be roughly classified as follows:

(1) To meet competition
(2) To give better service
(3) To fulfill an obligation resting upon a transportation system which has a monopoly of transportation
(4) To feed new territory at a minimum of investment expense

These are all very sound and economic reasons. I venture to suggest that in some cases at least the proper equipment was not chosen. Too much care cannot be given to this matter. Differences in types of vehicle may easily mean the difference between red and black figures at the end of the year.

Proper routing is another important element, probably not very well understood as yet. I have heard of one case in New England in which a study of this member of the equation changed a loss into a profit.

Speed of operation, a very important factor, is not covered adequately in the report. A change in engine size, gear reduction, or the like, which would raise the average speed of a city bus, even so much as 10 per cent, might also change a loss into a profit.

Little appears in the report on special forms of equipment for special services as such. These special services may, when properly catered to, mean the difference between a deficit and a surplus. The motorbus is excellently adaptable to express service, which even double-track street-railways cannot give. Double-deck buses, furthermore, create a traffic of their own, as people delight in the upper-deck comforts. They leave their motor cars at home and come into town on the buses. We know this from the results in New York City, Chicago and Detroit. The bus attracts the sightseer as no trolley car or single-deck bus can. I mention these points simply to bring out the fact that if all of these features of motorbus transportation are studied and their revenue-producing capacity made available, the net operating financial result can be considerably altered.

We have found in Detroit that 25-passenger one-man buses can be operated for very much less money per mile than even the small one-man street-cars, and they will be used extensively in the outlying territory in conjunction with the street-railway equipment of the city.

I had expected a complaint from your committee that much of the equipment that the members of your association have been compelled to buy was little more than built-over commercial-car chassis. The motorbus builder is open to criticism, in nearly all cases, in trying to do just this thing. Some of the companies, of course, have recently made up and developed special equipment. Bus service demands special equipment from end to end, designed primarily for bus service, the conditions and requirements of which are totally different from those obtaining in merchandise transportation.

Your practice shows a wide variation as to depreciation. Surely the bases given can be made more nearly uniform. On the whole, it seems that the figures taken are unnecessarily high. With the right equipment, that is one that will not soon become obsolete, a 10-year life is not too much to expect, when the vehicles are operated under good maintenance practice. The table prepared by the committee gives depreciation as about 13 per cent of the total expense on the average. This seems high. Of course, in the early days of any project it is wise to err on the safe side, but it seems that there were enough well established data, as evidenced by the London General Omnibus and the Fifth Avenue Coach Co. practice, to indicate 7 or 8 per cent as being an adequate depreciation. I note that your committee advises its members so study carefully the factors governing depreciation. This is very timely advice.

The earnest purpose of your association to take up the new instrument of transportation that our industry has produced, and to give it a fair trial, is very gratifying. We have unlimited confidence in its future. We know that we are just beginning to understand the problems to be met. We appreciate pretty well the necessity of special equipment. Working with you, we can more and more meet your requirements. On the other hand, you will have to give these new things a fair chance to show what can be accomplished, and to plan their operation, as you have done in most cases, with the idea of making them financially successful. The motorbus has many fundamental characteristics that make it excellently adaptable to filling a public need. It should enlarge your field of operations; enable you to hold business you otherwise would lose; and, properly combined with your railway operations, lead to ultimate economy of operation of the entire system.

I think it is the general opinion that the highest usefulness of the motorbus is attainable by street-railway organizations in conjunction with the rest of their equipment, rather than by competitive organizations.

The Society of Automotive Engineers hopes that this meeting today is just the first step along the road of cooperation that will be increasingly profitable to both yourselves and ourselves. We stand ready to do our utmost wherever we can be of assistance. It will give us great pleasure to have some representative of your organization present your problems to us at each of our transportation meetings, which we have decided to hold at least twice a year. I believe that the closest possible official cooperation between our two organizations is highly desirable. Our organization will leave no stone unturned to effect this cooperation.

Standardization Activities

The importance of the formulation and the reduction to practice of proper mechanical standards was emphasized repeatedly during the meeting, the object to be attained being a reduction of cost in the design, construction and operation of buses, as well as the enhancement of the quality of the product. At the close of the session at which the committee's report on bus operation was discussed, H. B. Keenan, superintendent of the bus division of the United Electric Railway Co., proposed that the American Electric Railway Association go on record as approving S. A. E. Standards and the standards of the affiliates of the Association. He advocated full interchangeability of assembly units, including engines, and simplification of practice with regard to screw threads. After stressing the importance of accessibility of bus parts in general, he expressed the opinion that

depreciation of 20 per cent per year is not reasonable and can be reduced. He recommended strongly that committee organization be effected to take up standards work before the bus industry becomes too old to put into effect promptly standards that may be established now. In this connection the full cooperation of the automotive industry was sought. In fact, there was much clear and striking evidence that the street-railway men desire to work closely with the representative organizations in the automotive field in the solution of various problems being encountered in the fast-growing and decidedly important bus industry.

Immediately after the conclusion of the session, President Alden addressed the executive committee of the American Electric Railway Association on the matter of joint procedure in the formulation of motorbus engineering standards. He stated that the Society had already decided to call a preliminary conference on this subject, with the purpose of organizing a special committee to study it. He asked that the American Electric Railway Association designate representatives to take part in the preliminary conference. This was done promptly, a committee being named by the street-railway interests.

BENZOL AS ENGINE FUEL[1]

THE use of light oil as engine fuel is of importance in districts adjacent to by-product coking operations from which a reasonable proportion of the local demand may be supplied. Furthermore, the certainty of diminution of petroleum resources in the relatively near future demands the utmost utilization of gasoline substitutes from the distillation of coal, as well as from other sources.

In ordinary coking practice from 1½ to 3 gal. of refined motor benzol is obtained per ton of coal carbonized. The crude benzol is yellow in color and contains sulphur compounds that corrode copper and brass; it also contains unsatured bodies that oxidize and polymerize on standing, producing sediment and forming gummy deposits. These along with the other impurities are highly objectionable when the benzol is used in internal-combustion engines and therefore must be removed by further refining and distillation.

How the Fuels Were Tested

To investigate the practical utility of these fuels the Bureau of Mines, in cooperation with the Davison Chemical Co., made engine tests on motor-benzol fuels refined by various methods. The testing equipment consisted of a four-cylinder, 1915 model, Lycoming engine, with cylinders of 3½-in. bore and 5-in. stroke. The engine was directly connected to a Sprague electric dynamometer and revolution counter, from which the brake load and the horsepower developed could be obtained. The speed of the engine was kept constant and an orifice plate inserted between the carbureter and the intake-manifold gave a non-varying throttle adjustment so that the amount of the fuel-air mixture entering the engine would be approximately constant. The fuel was supplied from a large graduated tank, and a record was kept of the weight of fuel consumed during each test. The air-fuel ratios 10.1 to 1 and 13.5 to 1, were calculated from an ultimate analysis of the fuel and the analysis of the exhaust gas. The testing period was set at 40 hr. at an engine speed of 100 r. p. m. The temperature of the cooling water flowing through the engine was kept at 150 deg. fahr., ± 1 deg. All readings were taken every 15 min., and samples of exhaust gas every hour. At the end of a run, the quantity of fuel consumed was measured; then the carbon was removed from the cylinder-head, cylinder block, spark-plugs, and piston-head and was weighed. The so-called gummy deposits, when present, were found to collect under the intake-valves, on the stems and in the intake-manifold, close to where the gas mixture entered the combustion-chamber. After each test these deposits were removed and weighed.

Performance of Different Fuels

The crude motor benzol used was a totally unrefined light oil direct from the wash-oil still of a large coke oven plant of the Koppers type. That portion boiling below 150 deg. cent. (302 deg. fahr.) was taken for the test. The run with this oil at a 10.1 to 1 air-fuel ratio showed that engine trouble was confined to gummy deposits sticking in certain of the intake-valves while the engine was stopped and became cold over night. At the end of the run, heavy gummy deposits were found in the intake-manifold and under the intake-valves. The deposits were hard and brittle and had little odor. With the 13.5 to 1 air-fuel ratio, considerable gummy deposits were noted in the intake-manifold and under the inlet-valves after a 16-hr. run.

It was concluded that crude motor benzol cannot be used satisfactorily in an internal-combustion engine until after certain compounds that form these gummy deposits are removed. These deposits, after a variable period of operation, prevent the valves from seating, cause the gases to pop back into the carbureter and eventually stop the engine.

The acid-refined motor benzol used was a crude light oil that had been washed with (*a*) sulphuric acid, (*b*) caustic soda solution and (*c*) water, and then redistilled up to a temperature of from 130 to 140 deg. cent. (266 to 284 deg. fahr.). With air-fuel ratios of 10 to 1 and 13.4 to 1, the engine ran satisfactorily throughout the full 40-hr. test, without any valve trouble. A very thin gummy deposit was found in the intake-manifold on two valve-stems, but the quantity was too small to weigh.

The crude benzol subjected to silica-gel refining was prepared from a new lot of crude light oil, which was distilled up to 143 deg. cent. (289.4 deg. fahr.). This distillate was vigorously agitated with 0.25 per cent of caustic soda in an equal weight of water. After ½ or 1 hr. of settling, the alkaline solution was carefully separated, and the benzol subjected to percolation through silica gel. This material had been finely ground, all passing through 150 mesh, and was freshly activated before being used.

With the silica-gel treated motor benzol and an air-fuel ratio of 10.4 to 1, no valve trouble developed during the 40-hr. run. A very small deposit was found in the intake-manifold, and a slight sooty deposit on the underside of the inlet-valve heads. The valve-stems were exceptionally clean; in fact, the inlet-valves and the intake-manifold were cleaner than in any previous test.

Conclusions

(1) Crude motor benzol cannot be used satisfactorily in an internal combustion engine

(2) Acid-refined or silica-gel refined benzols develop no engine troubles and are satisfactory to use therein, providing the refining process in either case is complete in removing the gum-forming constituents

(3) Variation in the air-fuel ratio in these tests showed no definite influence on the quantity of gummy deposits formed

(4) A motor-benzol fuel that gives an evaporation residue of less than 0.01 per cent by weight should not give gummy deposits in the intake-manifold and on the intake-valves, when used in an internal-combustion engine

[1] Synopsis of a monthly report of an investigation prepared by A. C. Fieldner and G. W. Jones of the Bureau of Mines Experiment Station, Pittsburgh.

Wage-Incentive Systems

By Eugene Bouton[1]

Production Meeting Paper *Illustrated with* **Charts**

NUMEROUS wage-incentive plans are now in operation in the various automotive and other industrial plants; but the proper system to install in a given plant, whereby unit costs will be maintained level and at the same time proper cooperation from employes will be obtained, has always been open to discussion.

One plan now in use by the company represented by the author is straight individual piece-work on small-parts operation where one, two or even three operations complete the particular part, and where only one or two operators are engaged in machining or assembling the particular unit; whereas, on the major machining and assembly units such as cylinder-block machining and engine or complete-car-assembly units group piece-work is employed throughout the entire plant.

By the installation of individual and of group piece-work, unit costs are maintained level at all times; in addition, the workmen employed are able to determine very easily by their own calculations what they have earned either daily or at any hour of the day. This is in direct contrast to other and more complicated systems wherein unit costs are not maintained level over given periods and workmen in many cases are required to work for a complete pay-period without being able to ascertain their earnings over and above their guaranteed day-rates.

Still another feature of the group and the individual piece-work plan is the small clerical force necessary for the functioning of the system. Our company and its employes feel that the wage-incentive plans now in operation have met all of the principal objections generally experienced with other wage-incentive systems.

WAGE-INCENTIVE systems constitute one of the important problems of the industrial world. Many writers on wage systems, management and personnel administration cover their systems very well; but their articles are largely lacking in statistical information. In modern industry, the unit-cost of production is an important factor. It does not matter how much a man receives per hour or per day if his output is in proportion to his wages. There are many plants that are so well organized that they pay high wages and yet have a low production-cost, while other plants more poorly organized have a high unit-cost of production in spite of the fact that they are paying low wages.

Practically all managers of modern plants believe that some wage-incentive plan is necessary to attain the highest production possible. The subject of most discussions regarding wage-incentive plans is: What is the proper system to install? Many men state that standard time is the best, while it is claimed by others that straight piece-work, group-bonus, premium and the like are much better. It would be interesting indeed to survey all the plants in the automotive industry to determine what wage-incentive systems are in use, to tabulate them in divisions, and thus show exactly which systems are most favored. Some of the systems now in use are highly complicated and involve a large amount of clerical work and maintenance expense. Using such systems, the employer does not know with certainty in advance just what the direct labor-cost will be, nor does the employe know what his earnings will amount to in a pay-period. As a rule, costs and earnings are compiled at the end of a pay-period or every month.

GROUP PIECE WORK

OPERATION AND ROUTING SHEET

Date 6-6-23

Group No. 101

Part Name INTAKE & EXHAUST MANIFOLD ASSEMBLY Part No. 7109A

Material Cast Iron Model 32 Req. per car 1 Sheet No. 1

OPER. No	OPERATION	PRICE	HRLY. PROD.	TOOL No.	TOOLS OR EQUIPMENT
1	The following operations on Part No. 7109, Exhaust Manifold, No. 7115 Intake Manifold and the Manifold Assembly to be worked as a group for the price per completed Manifold as shown:-	——	1.14		(See Below)
	Part No. 7109.				
	a. Bore exhaust end		18.6	700	Cincinnati Drill Holding Fixture
	b. Mill flanges		7.1	125	Brown & Sharpe Mill Double Mill Fixture
	c. Mill face pad		7.75	101	#3 Cincinnati Mill Double Mill Fixture
	d. Drill (7) 17/64" holes		23.1	36	Colburn Drill Press Drill Jig
	e. Mill air pad		21.8	249	#2 Cincinnati Mill Milling Fixture
	f. Drill & tap (4) 5/16"-18air pad holes for cover		22.9	273	Hammond Radial Drill Holding Fixture Drill Jig
	g. Tap (7) 5/16"-18 face pad holes and drill for & tap (2) 5/16"-18 exhaust flange holes		21.6	322	Hammond Radial Drill (2) Holding Fixtures (1) Drill template
	Part No. 7115.				
	a. Mill flanges		7.1	125	Brown & Sharpe Mill Double Mill Fixture
	b. Mill face pad		7.75	101	#3 Cincinnati Mill Double Mill Fixture
	c. Drill (8) 11/32" face pad holes		22.6	36	Colburn Drill Press Drill Jig.
	d. Spotface (7) bolt hole bosses		35.1	133	Cincinnati Drill Press Holding Fixture
	Manifold Assembly				
	a. Assembly intake & exhaust manifolds		6.13		Assembly Bench Holding Fixture
	b. Drill (10) 15/32" and (8) 7/16" flange holes.		19.5	119	Natco Multiple Drill Indexing Fixture
	c. Mill carburetor pad		22.9	315	#3 Cincinnati Mill Holding Fixture
	d. Drill (2) 25/64" holes for carbreter bolts and chamfer intake ports		16.9	133	Cincinnati Drill Holding Fixture

Remarks All operations to be worked as a group and the total earnings pro-rated among the number of men working in the group in proportion to their hourly rates. Approved

Fig. 1—An Operation and Routing Sheet for Group Piece-Work

Manufacturing conditions, as well as the manufacturing processes in the departments of a large plant, vary considerably and cause entirely different problems to arise. Therefore, a single wage-incentive plan which will fit all departments in an automobile plant satisfactorily is yet to be evolved. The straight piece-work system has been criticized severely by both employer and employe, sometimes unjustly because of the application of piece-work to operations which do not lend themselves to this form of wage-incentive. When the correct and applicable system is used, the opposition of labor is reduced to the minimum. However, there are many

[1] Supervisor of time study, Chandler Motor Car Co., Cleveland.

GROUP PIECE WORK

OPERATION AND ROUTING SHEET

Date 9-21-23

Part Name CHASSIS, BODY, FINAL, SUB-ASSEMBLIES & WIRING GROUP Part No. 75

Material Model 32 Req. per car 1 Sheet No. 1

OPER. No.	OPERATION	PRICE	HRLY. PROD.	TOOL No.	TOOLS OR EQUIPMENT
1	The following operations are to be performed by the entire group:-	—			
	a. All operations on conveyor from spring mounting to finished car including spraying of chassis.				Assembly Track
	b. All sub-assembly operations excepting running boards and floor boards which are to be worked on individual piece-work.				Sub-assembly Benches Wheel Department
	c. All body assembly, covering all model cars.				Body Department.
	d. Assembly all cables, ready for car; assemble all ignition & lighting wires ready for car, all models; assemble instrument panel complete; assemble dispatch switch.				Wiring Department

NOTE:- The above price per completed car and is to be worked as a group covering all men working on operations or parts of operations described above.
The total group earnings are to be pro-rated among the total number of men in the entire group according to the individual employee's day rate.
This price applies to all model cars built.

Remarks Approved

Fig. 2—Another Group Piece-Work Operation and Routing Sheet

operations in connection with which straight piece-work is perhaps the best incentive-plan to apply. The same is true of other forms of wage-payment plans whenever one particular system is used throughout a factory.

A Combination of Systems

The company I represent has adopted the group piece-work plan for the major assembly units and machining departments, sample forms being shown in Figs. 1 and 2. Straight individual piece-work, a record form for which is shown in Fig. 3, is used for small parts on which the operations do not lend themselves very readily to group piece-work and which are, in fact, apart from any group of men or operations which involve only one, two or three operations to complete the part. The piece-work prices are established from data obtained in an elemental time-study. The time-study record is shown in Fig. 4.

The group piece-work plan is fundamentally the same as straight piece-work. A time-study of all the operations in the entire group is taken, reasonable allowances for fatigue, tools and contingencies are made, and the price is set based on the additive time. The group earnings are derived from the number of accepted finished units multiplied by the unit price. The individual workman's earnings are prorated out of the group earnings based on his hourly rate and the number of hours worked. A simple method of figuring the individual earnings is that: The total group piece-work earnings divided by the total day-rate earnings of the group equals the factor by which is multiplied the workmen's day-rate earnings; this gives his prorated piece-work amount. Thus,

$$W = T/D \times H \times R$$

where

D = Total group hourly-rate
H = Hours worked
R = Hourly rate
T = Total group-earnings
W = Employe's total earnings

Differentiation of Hourly Rates

One of the important factors in the successful operation of the group plan is the differentiation of hourly rates. The most careful judgment should be exercised in rating the men according to their ability and to the skill required to perform the respective operations. All unskilled operators, including new men, should receive the minimum hourly-rate; skilled and semi-skilled workmen should be rated accordingly, above the minimum rate. Maximum and minimum hourly-rates are specified by the management and all rates must be within those specified. If a workman requests an increase in hourly rate, and the increase is favorably recommended by the department foreman, this can be granted without increasing the cost of the unit, as the workman simply receives a higher prorated share of the total group-earnings. This has been an important and satisfactory factor in the revision of rates, and balances better the earnings of the various operators according to the work which they perform.

Number of Men Required

Another feature of the group piece-work plan is the immediate determination by the foreman of the number

INDIVIDUAL PIECE WORK

OPERATION AND ROUTING SHEET

Date 8-2-23

Part Name CRANKSHAFT BEARING CAP - FRONT Part No. 20123

Material Aluminum Model 32 Req. per car 1 Sheet No. 1

OPER. No.	OPERATION	PRICE	HRLY. PROD.	TOOL No.	TOOLS OR EQUIPMENT
1	Mill bottom surface	.0080	83	22	Cinn. Vertical Mill Milling Fixture
2	Drill (4) stud holes	.0130	47.4	120	Natco Multi. Drill Drilling Fixture
3	Ream (4) stud holes	.0077	83.2	568	Canedy Otto Drill Press
4	Spotface (4) stud holes	.0092	70	568	Canedy Otto Drill Press

Remarks Supersedes sheet dated 4-27-23 Approved

Fig. 3—Operation and Routing Sheet for Individual Piece-Work

of men required to produce according to any given schedule of units. For example, if it requires 100 men to finish 100 units per day and the schedule of production should drop to 75, practically 75 men would be required to produce 75 units. However, if the schedule should drop to 50, it would, in actual practice, require a few more than 50 men, due to the fact that each workman would have to perform more operations and individual production would be limited for that reason. Likewise, when the schedule of production is increased, say to 150 units per day, it would not require 50 additional men in actual practice.

Unit-Cost

The group or cost price of each unit should be based on a schedule as nearly uniform as it is possible to set, and a slight fluctuation either upward or downward would not affect the price. Any wide variation in production would tend to change the original rate, and necessitate a slight change in the piece-work price of the unit. Little has been said by others about this feature of group work, but it is a factor to be reckoned with at certain times of the year when production fluctuates. However, how far from the original schedule we can go, either upward or downward, before the price is affected, is to be determined in any individual plant wherever the group prices are established.

Adding New Men

When a new employe is added to the group, he can be allowed to work in the group 2 days at his regular day-rate before participating in the group earnings. After that period he is prorated among the group. Should the new employe be too slow, or not satisfactory to the rest of the group, he is taken out. In this way the company bears a portion of the expense of breaking-in the new man, and so does the group. At our plant, as a rule, when a new employe is put into the group, he is started-off at the group price. In cases where the labor turnover would be exceedingly high for a short period, one way to handle the new employe is to place him on his hourly day-rate for a period of 2 or 3 days and deduct this amount from the group earnings; but, as stated previously, we have never had to apply this feature.

The employes are desirous of earning as much money as possible; therefore, their interest in the group is also to keep the number of employes down to the minimum. The spirit of teamwork is developed in each group, and the inefficient workers are eliminated by the other group-workers; this relieves the foreman to some extent of this phase of supervision.

TIME STUDY RECORD

DATE ______ PART NO. ______
OPER. NO. ______
NAME OF PART ______ MAT'L ______ MACH. NO. ______
DESCRIPTION OF OPER. ______ DEPT NO. ______
OPERATOR

SUB-OPER.	TOOL NUMBER	NAME OF TOOL	TOOL SET-UP
			TIME PRICE
			FLAT TIME PER PIECE
			TOOL ALLOWANCE PER PIECE
			TOTAL TIME PER PIECE
			60 ÷ = NO. PC'S PER HOUR
			= PC'S ON WHICH TO SET PRICE
			÷ = PRICE PER PIECE
			BASE RATE PRICE PER 100

SUB-OPERATIONS	SPEED	FEED	DEPTH CUT	LENGTH CUT	FEET MIN.	ACTUAL TIME TAKEN	AVER.
TOTAL							

PREVIOUS PRICE LUBRICANT BRINELL
SCLERISCOPE
REMARKS

SIGNED ______ APPROVED ______ APPROVED ______

Fig. 4—The Time-Study Record

Inspector's Report

Date ______ Part No. ______ Group ______

Quantity O K	REJECTED Quan	REJECTED Last Operation	SCRAPPED Quan	SCRAPPED Last Operation

Remarks

Note: This report to be turned into time office not later than 8 A. M. following day.

______ Inspector

Fig. 5—Inspector's Report Blank

Records

An inspector's coupon, shown in Fig. 5, is made out by the inspection department. It shows the number of units completed daily in each group, and the quantity OK'ed and rejected; and is turned into the time-keeping office not later than 8:00 a. m. the following day. From this inspector's coupon the time-keeping department makes up a group piece-work report showing all of the employes in the group, the number of hours worked and the amount earned according to their hourly day-rates; it is illustrated in Fig. 6. The report is made in quadruplicate; the first copy goes to the pay-roll department, the second to the time-study department, the third to the foreman of the department and the fourth copy is retained by the time-keeping department. The foreman of each department is enabled to know before 10:00 a. m. each day just what each individual's earnings were for the previous day. This feature of the group system is highly favored by the employes.

Some of our employes have worked on group systems in other plants, and could not be informed what their earnings were until the end of the pay-period. The ability to inform the employe on a given day what his earnings were on the previous day is one of the reasons the method described is favored by both the company I represent and its employes. If an employe quits or is discharged, we can calculate his pay from the number of units finished at any hour of the day, inasmuch as we know how many units have been completed up to that time.

The only time-card used is an in-and-out card showing the employe's attendance. The time-cards are stamped by the time-keeping department, indicating the

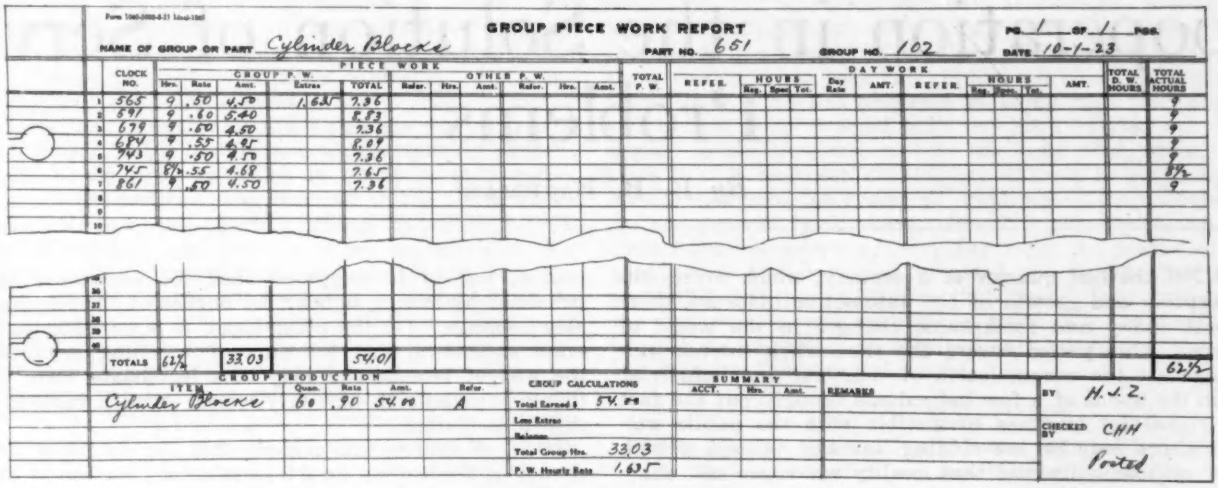


Fig. 6—Group Piece-Work Report

group number to which the workman is assigned; the employe merely rings "in" and "out" upon entering and leaving the factory.

Group Size

The question often arises as to the proper size of a group. We have found that the group should be limited to the unit itself. There should be not more than one group on any one unit. We have in operation one group of 92 men, and one group of 83 men; the smaller groups run as low as 3 men. Other groups are of 10, 15 and 20 men. Each group of men completes one unit. By having the group gaged according to the unit, there is no tendency for any of the prices or for production to be out of balance. For example, if two groups were engaged in one unit, one group might be short 2 or 3 men and not be able to furnish the second group with enough units to keep its men busy; the latter would be limited to what the first group produced; but, by having all in one group, the production would be balanced to suit the number of men engaged. There is a limit perhaps to the size of a group, but we have yet to find what the high limit is.

Material Supply and Costs

Whenever parts needed by a group-unit are required for service, the service department issues a requisition in duplicate, one copy of which goes to the time-keeping department as a check against the number of pieces withdrawn. For example, the service department may require 100 valve-lifter assemblies. The engine-assembly group assembles the valve lifters that are paid for at a certain price per piece, and the total earnings from these service parts assembled are added to the group earnings and prorated among the entire group. All piece prices covering service parts are established from the time studies made on the component parts of the group when the group unit is originally timed. Thus, with a flat price on any group, the management, the cost department and the employes know at all times what the price per unit is. There are no bonus nor premium calculations which in any way vary the costs.

Any increase in workmen's hourly-rates does not affect the cost, and the one thing that the employer wants to know with certainty at all times is just what the direct labor cost is. A definite understanding is had between the employer and the employes as to the amount of work to be produced for the compensation to be received. Failure of some systems to accomplish this has been the principal reason for objections to other wage-incentive plans. Some of these systems are so complicated that the employe cannot understand them or figure his own wages; it is also necessary for the cost department to maintain a large clerical force to keep the proper records needed to secure costs. The costs so obtained are subject to fluctuations, and it is necessary to compile them for a period of from 6 to 12 months to obtain an average cost. It seems, then, that the ideal system is one which can be "sold" to the employer and the employe as well, and will tell at all times the definite work to be done and what the compensation therefor shall be. It appears that many systems that have been devised have been wholly lacking in this respect.

Our company and its employes feel that the group piece-work and the straight piece-work methods now in operation in our plant have met all of the principal objections generally experienced with other wage-incentive systems, and think that this system is satisfactory in every way.

AUTOMOBILE INTERIORS MORE COMFORTABLE

Attention has been called previously to a simple means for decreasing the heat radiated through a tent or other light covering that is exposed to the sun. By coating the underside of the tent cloth with aluminum paint, the heat radiated from the underside is reduced by 86 per cent. Painting the outside with aluminum paint was found to be slightly less efficient, the heat radiated from the underside being reduced only about 80 per cent.

Coverings of conveyances, such as, for example, the tops of automobiles, ice wagons, etc., consist of cloth, the outside of which is often painted with a black composition that absorbs perhaps 90 per cent of the sun's rays. Practically half of this is radiated from the underside of the cloth. Tests are in progress at the Bureau of Standards which show that a coating of aluminum paint applied either to the outside or inside of such tops reduces by 50 to 60 per cent the intensity of the heat radiated from the underside into the interior.—Bureau of Standards Technical News Bulletin.

Cooperation in the Solution of Service Problems[1]

By B. B. BACHMAN[2]

DURING the last quarter of a century, which covers the inception and growth of the automotive industry, there have been many and remarkable changes in the world of commerce. This period covers the time when intense agitation against the accumulation of financial and industrial power in the hands of a few individuals brought out the fact that a successful business compatible with the public welfare must not only be law-abiding but also possess a high sense of responsibility and that quality which we call character.

In the beginning of our industry, founded as it was on the invention of a new device, the individual occupied a most conspicuous place. This was a phase that passed rapidly, but during this period and for some time thereafter we saw this individualism strongly emphasized. Sales appeal was first based on novelty and the sporting instinct as it reacted to the speed possibilities; following this, the matter of luxury of appearance and appointment, and, finally, the question of transportation facility.

With this change in perspective and the continually broadening market opened up by the reduction in price made possible by an increasing volume of production, the importance of the individual and of the efforts of inventive genius as evidenced by distinctive mechanical details, has given place to the collective efforts of an organization in developing the automobile and fitting it into the fabric of our national life as the principal means of individual transportation. This development in design and the methods of production are not sufficient in themselves, however, to make it possible for the automobile to give a satisfactory performance in this field.

It seems to be fundamentally sound to anticipate that a piece of mechanism as complicated as an automobile, even if placed in the hands of the most expert operator but subjected to the variables of climate and road condition to which it is generally exposed, would, even if initially perfect in design and in the selection of materials and in the manufacture and assembly of component parts, be subject to wear and depreciation which sometime or other during the life of the device would require attention in the way of adjustment, repair or renewal of parts, which could only be taken care of properly in an adequately equipped shop, manned by a trained and intelligent organization. It seems to be equally rational to assume that the provision of such facilities constitute an adjunct to the business of building and selling automobiles which can not only perform its functions to the enhancement of the reputation of the product which it serves, but also accomplish this result on a profitable basis.

If under the ideal conditions outlined in the foregoing, we recognize the need for a service organization, it is at once manifest that a departure from this ideal state by the introduction of other complicating factors such as inexpert operation, mistakes in design, shortcomings in manufacture in both materials and parts, to mention but a few, makes it absolutely essential that any product, to be successful in the hands of the user, must have these service facilities.

CONDITIONS OF MANUFACTURE

It is probably too much to expect that a vehicle as it leaves the builder's hands should be perfect and that no variables of performance or construction should be present. In the event of the presence of these variables it is, of course, not to be supposed that the purchaser should be penalized by having to bear the burden of the results of these shortcomings. On the other hand, it is possible that a moderate expenditure on the part of a selling organization in the way of free service may be a legitimate form of advertising, especially in new territories, or with particularly unskilled operators.

It is, of course, self-evident that the facilities mentioned cannot of themselves insure satisfactory service or that minimum of maintenance expense which is rapidly becoming essential. The designer cannot content himself with creating a cleancut, neat design with proper factors of safety in materials and adequate bearing surfaces and facilities for lubrication if the components are so related to each other that the machine can be repaired only with an unwarranted expenditure of labor and the use of special tools and equipment. He must recognize that there are certain things which will happen, making repair and adjustment necessary, and must provide in the design that this can be done easily and economically, just as he knows there are certain things which must not fail except under the most extreme circumstances.

In laying down a design for a vehicle, there are a number of limiting factors which must be taken into consideration. Some of these are of a commercial nature, such as the market to be reached and the price-level to be established. Some of them are of a technical nature, such as the power and performance expected and the strength and endurance to be built into the design. Others have to do with production, such as the character of the parts in relation to the equipment and the plant available. Some of them have to do with operation and service, such as the number and the complexity of the parts and the accessibility for repair and adjustment.

This classification is not definite, for the reason that these requirements overlap, some of them having to be considered from several angles. It is obvious that a 100-per cent solution of the problem, taking into consideration all of these factors, is difficult, if not impossible. The result will therefore be a compromise in which some of these details have been given preference over others.

In most organizations the influence of their commercial, sales and production divisions are closer to the designer than is the service end, with the result that more attention is paid to ease and economy of construction and to appearance than to the equally important matter of accessibility and simplicity in maintenance. I believe that one reason why this is so is that there has not been the unified opinion from the service department as a result of cooperative activity that there has been from the other divisions.

ELEMENTS OF SERVICE FACILITIES

Accordingly, we can say that the interest of the manufacturer in the establishment and maintenance of adequate service facilities lies in three directions: first, that his product shall be placed in the hands of the prospective user with such instructions as are essential to insure its being operated in a correct manner; second, that along with the facilities for selling the product there shall be adjacent to each user an organization and equipment competent to remedy such defects in design and construction as may exist and for which he is responsible, and facilities for the supply of corresponding renewal parts, and for the performance of such repair work as will be necessary due to normal depreciation from usage; third, an organization which on account of its competence and familiarity with the product can report the

[1] Presented at Chicago Service Meeting of National Automobile Chamber of Commerce.

[2] President, Society of Automotive Engineers, Inc.; engineer, Autocar Co., Ardmore, Pa.

nature and scope of difficulties that develop in service, due to either defective construction or normal usage, together with a criticism of the design from the viewpoint of accessibility, for the purpose of permitting intelligent and constant development and improvement of the product.

It may seem that the valuable aid which the service organization can render to the selling and manufacturing departments would be an asset in which it would be a desirable thing for an individual company to excel to the point where no one else could compete. Such a conception would require guarding the methods and the processes in use with the greatest secrecy. The growth of the industry in the past and its potential growth in the future make it evident that no individual organization can possibly control this factor or supply the facilities that should be available to provide adequately for even its own product.

As the automotive industry grows and as competition becomes keener, as the general public becomes more automobile-wise, the question of the cost of maintaining the equipment in operation will bear a larger and larger significance. The United States is the only country that, up to this time, has adopted the automobile as an everyday, all-the-year round, continuous means of transportation. One reason for this is that we have, in view of the character of design and our methods of production, been able to place vehicles in the hands of the public at prices that came within the reach of everyone, irrespective of social or financial conditions.

The matter of the oft-discussed topic of the saturation point of the automobile market bears no significance in my mind, except insofar as we are unable to find practical means for keeping the cost of operation down to reasonable figures. How to do this has no part as a subject in my discussion, but is a subject with which the service-man and the service organization are most intimately and vitally concerned, and the sooner the service people can get together and discuss this problem from all its manifold angles and present the subject, analyzed and in detail, to the sales, production and engineering departments of the organizations with which they are connected, the sooner will we begin to make real progress along this line. It is probably unnecessary to point out that considerable progress can be made and, as stated before, is absolutely essential.

Increased Cooperation Needed

The spirit of the times is for increased cooperation in the development of matters of this sort that will move forward the individual with the industry. This cooperation does not mean the elimination of rational competition but it does mean the elimination of unreasoning antipathy to associating and exchanging experience on a cooperative basis with others in the same line of endeavor. It is not so many years ago that the automobile industry was composed of a group of units, each individual being suspicious of the methods and ideals of its competitors. Our factories were locked up, and particularly our experimental and engineering departments were kept guarded in a most jealous manner.

The contact between and the association of manufacturers that has been developed in the National Automobile Chamber of Commerce, growing out of the Association of Licensed Automobile Manufacturers, and the interchange of ideas and the expansion of knowledge which have resulted from the growth of the Society of Automotive Engineers, successor to the old mechanical branch of the Association of Licensed Automobile Manufacturers, have been in harmony with the increase in cooperation in all lines of endeavor. The results have indicated how much is to be gained by this form of association and interchange of ideas.

The Society of Automotive Engineers has recognized for some time that in the automotive field, as in that of the railroad, there will eventually be many more engineers occupied with the operation of vehicles than with their design and construction, and that to become a truly representative organization for the engineering fraternity of the automotive field it will be necessary to widen its field of operations and the scope of its programs to provide for this large and rapidly growing class of men. Therefore, within the last several years there have been held at Chicago, in connection with the National Automobile Show, meetings of the Society devoted to the subject of service. While the attendance at these meetings has been fair, it has not come up to the full possibilities. We are prepared to admit that the programs which have been selected may not have carried the fullest appeal to the service-men. At the same time, it is fair to state that it has been exceedingly difficult to get competent service-men into the frame of mind where they would open up and present their views. Possibly the service-men as a class have not advanced very far from the status of mere repair-men and have not obtained the broad view of the necessities and possibilities in their field. I am not criticizing but merely endeavoring to point out the need for a broader viewpoint, to be obtained only by mixing and thinking in more fundamental terms.

Engineering Fields

There are two general fields in the automobile industry in which the engineer has an opportunity to use his talents. These are constituted of many subdivisions with which I will not attempt to deal. One field is that of construction, incorporating the subdivisions of research, design, development and production. The second is the field of operation, embracing the subdivisions of service and application. You will understand readily that the first engineering talent which came to notice in the industry was that which designed the vehicle. No ingenuity could be exercised in constructing and servicing vehicles until the designs had been created. We can all recall the advertisements of earlier days in which the names of famous designers were placed before the public as sufficient reason for their purchasing.

Following this creative period, we came to the time of rapidly expanding production. It is only natural that, with an eager public apparently able to absorb an almost unlimited output, the problems of service should have received relatively less attention than those of production. I believe that this condition has changed, and that we are entering into a third period in which the question of properly selling the product and of keeping it sold is involved.

It is of fundamental importance to the growth of the industry that professional jealousy or antipathy between the various divisions mentioned should be eliminated and that in their stead there should come the most complete harmony and cooperation. It is manifestly impossible for any but the most exceptional man to become expert in all these various lines. It is equally certain that expert advice from all of these fields is necessary to develop the automotive vehicle satisfactorily. It is therefore essential to attaining this end that organizations exist in which the members of the different groups can cooperate and interchange experiences with their fellows in the same group and in the entire field.

To do this, as I have suggested before, requires a broader vision of the subject than is possible for the ordinary man to obtain in his own limited sphere of activities. The value of service to the industry and the importance of the service-man are such that he should not be content to drift along with the times, but should take active steps to place his part of the industry and himself on a par with all of the other divisions and individuals.

I believe that the only way that this can be done is by effective cooperation. The formation of local service organizations is an excellent and effective method of accomplishing this in a very large degree. There are, however, many phases in the business of service and each has its own problems as well as common ones. As an engineer, I naturally see the engineering side most clearly, and therefore in addition to this form of general organization, I believe that the service engineer should avail himself of every opportunity for association with his fellows in the industry.

It is in this field that I believe the Society of Automotive Engineers can be of assistance. The constitution of the Society, in citing qualifications for membership, recognizes the standing of the competent engineer in the service field, as well as in the production and designing fields. For the service engineer to analyze his problems correctly, he must

have, in addition to the experience gained by close association with the vehicle in operation, a broad view of the principles underlying the design and the production of the vehicle. It is just as important to him as it is to the designer to have before him the necessities of operation. To get this broader viewpoint, they both need the more intimate contact that the Society has the means to provide, if advantage is taken of its facilities.

In closing, let me emphasize the following:

(1) Automobiles are a transportation necessity
(2) To fill this need satisfactorily, there must exist efficient and sufficient service facilities
(3) We have not these facilities in the necessary quantity and quality today
(4) The business of furnishing service in this field of transportation can be made profitable if conducted properly
(5) To conduct it properly, and thereby profitably, much must be learned and many problems solved
(6) In learning the requirements and solving these problems, cooperative endeavor in helping the weak to become strong will help the strong to become stronger

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SIMPLIFICATION

JUST as the manufacture of goods on a large scale reduces their cost and hence permits price reductions that augment the sales volume, and the increased sales volume thus attained again conduces to yet lower manufacturing costs, so do the various operating advantages of simplification within an establishment all tend to augment and multiply one another. Suppose, for example, simplification takes place in the variety of the product manufactured. The elimination of certain items from the line and concentration upon others then cause longer machine-runs and a lowering of unit overhead costs, both through continued utilization of the equipment and through the avoidance of setting-up expense. But automatically, the standard practice that brings about such savings in production results in other savings outside the operating departments. Stores, accounting and planning departments are inevitably affected; regular repetitive production entails less expense in the way of record-keeping and the maintenance of various control devices in auxiliary departments.

Better control of materials, simpler accounting methods and more timely planning and scheduling then result in stabilized operation; which further conduces to lowered costs, better quality product, smaller inventories, shipment that is prompter and delivery that is more dependable. The latter advantages then again result in yet larger sales. Buying in larger quantities obtains still more favorable quotations from sellers. Steady and continuous operation reduces labor turnover and gives the management its pick of both skilled and unskilled labor.

It is the sum total of all of these cumulative, interrelated differentials which counts. In many cases, the saving in any one department may be slight when considered by itself, but the effect that it will have upon the other departments and the savings of the second and third departments in relation to their effects, again, upon the first department bulk large when taken together. The stabilization of all business operations permits a better control over costs. A knowledge of costs permits control over sales. Control over sales permits their coordination with production, and the coordination of production and sales results in the general stabilization of employment, advertising, promotional and financing operations. Thus, cumulatively, the workings of each step in simplification affect the operations of the entire enterprise.

Very properly, in its pioneer stage each commodity runs the gamut of various types and patterns, shapes and sizes, in finding those best suited to its purpose and market. After these are established, however, useless differentiations tend to persist. As we swing into each new field of production, that field, for the time being, gives play to the human desire for ostentation, variety and luxury; but as time goes on those desires center themselves in new devices and commodities, leaving behind a number of types and varieties of product that ordinary economic processes only slowly, if ever, eliminate.

This development is paralleled by a needless complexity and indirection in production methods, marketing practices and the general minutiæ of control. Unnecessary motions become embedded all along the routine of making and selling. A possibility for a dual combing process results and in this lies the opportunity for real simplification. To obtain an increased output from fields already being worked and to free our productivity for enterprises in new fields a conscious overhauling is repeatedly required at certain stated intervals.

On the one hand those types and varieties that have been demonstrated to be ineffective should be weeded out as rapidly as possible. Once the pioneer stage in the production of any variety or type of a commodity is past, it should be subjected to a scrutinizing survey, rather than to wait on the slow processes of natural elimination. On the other hand, all unnecessary practices in connection with manufacture and sale, in purchasing, in fabrication or processing, in storage, in shipments and deliveries, even in finance and accounting, should be discountenanced with equal vigor. As the conditions of trade or manufacture change, scrutiny should be repeated to detect again any unnecessary motions. Finally, all new steps proposed should be carefully examined and critically challenged in the light of whatever added complexity to operations or processes they may entail.

So far as diversity of products may be involved, simplification is not hostile to any styles or varieties of product that appeal to the public fancy. It aims, first, only at eliminating those varieties and types that do not serve even a semi-frivolous purpose; and it aims, also, at giving to the non-frivolous elements in the population a chance to purchase articles of sound utility at minimum prices. And, secondly, by eliminating all unnecessary steps and practices in the productive, distributive and facilitative activities of each plant or store, simplification aims, further, at giving to the entire community an increased volume of goods and services and a higher standard of living.—A. W. Shaw in *Harvard Business Review*.

Developments in Production Grinding in the Automotive Industry

By Oscar A. Knight[1]

Production Meeting Paper

Illustrated with Photographs and Drawings

In production grinding the progress made during the past few years has been along the line of grinding multiple parts simultaneously, such as piston-rings, ball and roller-bearing cups and so forth. This kind of grinding brought about the use of wider wheels to cover the entire surface of the work whereas formerly narrow wheels had been used with the traversing table method. With the development of these operations came the cylindrical grinding of square and distributor cams; also square shafts, using the oscillating cam grinding attachments; piston relief grinding with the same attachments; and two-wheel or double-wheel grinding for such parts as steering-knuckles and pinion shafts of different diameters or where two diameters are separated by some protrusion, as in steering-gear worm-shafts.

To accomplish these new operations more care has been taken to build machines that are heavier, stronger and more accurate so that operators can place greater dependence upon the mechanisms than was possible with previous machines. Greater care has been taken to balance the grinding wheels more accurately to overcome imperfections in finish and to eliminate excessive repairs on the grinding machine itself. Some of the new attachments, mechanisms and grinding machines are described in detail in the paper.

In conclusion the author states that the automotive industry has become the chief element in machine-tool business in the Country at the present moment and therefore the principal factor in forcing new developments in machine-tool design. He also points out the importance of a quality product to serve the needs of the automotive industry adequately.

[1] Detroit district manager, Norton Co., Worcester, Mass.

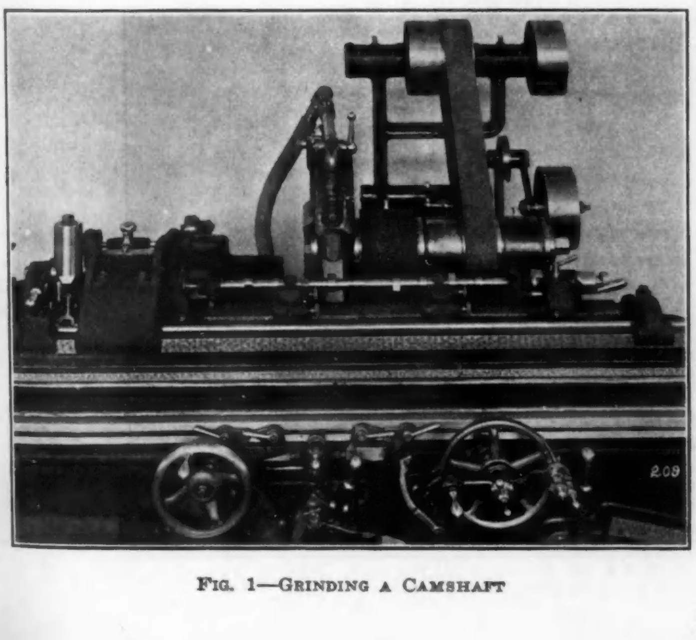

Fig. 1—Grinding a Camshaft

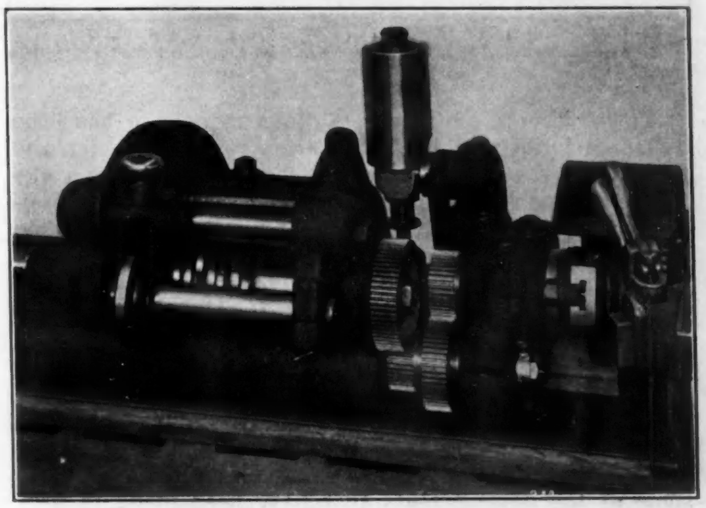

Fig. 2—Attachment for Grinding Cams

Advancement and development in any art or science is brought about by necessity, and the developments in precision grinding in the automotive industry have been accomplished to meet the demands for greater production and refinement at less cost. To cover the developments that have been made in all classes of production grinding would consume too much time. Therefore, I will deal with only one class, namely, cylindrical production grinding as performed within the automotive industry, with only a slight reference to other classes. Production grinding should also be classified as *precision* grinding because to secure the largest production of good ground-work the exact limits required for size and finish must be considered. Webster defines "precision" as "exact limitation, strict conformity to a rule or standard." This means that modern precision production grinding is always performed within exact limitation to some given rule or standard.

The progress made in production grinding during the past few years has been along the line of multiple-work grinding on such parts as piston-rings and roller- and ball-bearing cups. It brought about the use of much wider grinding-wheels to cover the entire surface of work that had formerly been ground with narrow wheels by the traversing table method. Along with the development of these operations came the cylindrical grinding of square and distributer cams; also square shafts, using oscillating cam-grinding attachments; piston relief grinding, with the same attachments; and two-wheel or double-wheel grinding for such parts as steering-knuckles and pinion shafts of different diameters or where two diameters are separated by some protrusion as in steering-gear worm-shafts.

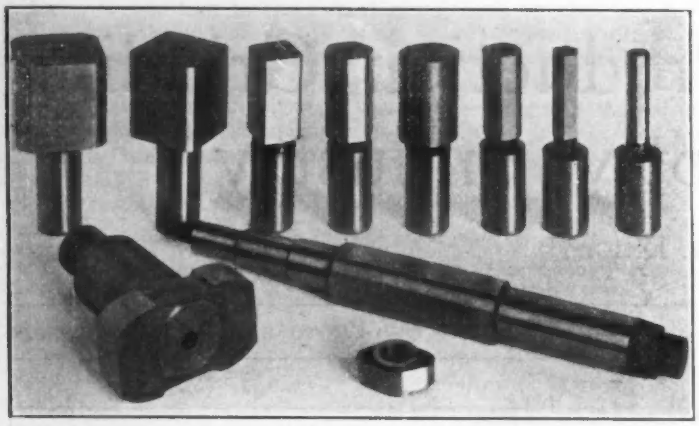

FIG. 3—EXAMPLES OF THE WORK THAT IS DONE ON THE GRINDING MACHINE

To perform these new operations more care has been taken to build machines that are stronger, heavier and more accurate so that operators can place greater dependence upon the operating mechanism than was possible with previous machines. Greater care has to be taken to balance the grinding wheels more accurately to overcome imperfections in finish and to eliminate excessive repairs on the grinding machine itself. At the same time, grinding-machine builders have devised means for bringing back into approximate running-balance wheels that have developed vibrations as they have worn smaller in their use.

New machines and special attachments have been put into use recently and the accompanying illustrations show some of the developments that have been made in production grinding in the automotive industry. It is unfortunate that some of the very best examples of real progress could not be photographed for inclusion in the paper.

CAM GRINDING

In the early days of the industry cams were made individually and pressed over a staight shaft and located in their respective positions by a Woodruff key. The attachment which ground these individual cams according to the shape required, oscillated in its movement. The shape was reproduced from a master cam contained within a case that formed part of the attachment.

Engineering progress caused a change in this part and whole camshafts with all cams forged in place were given to the grinding engineers. One of these shafts mounted in the grinding machine is shown in Fig. 1.

To meet this situation the integral cam-grinding attachment, which could be placed on the table of machines already being manufactured for other classes of grinding, was produced, and all the cams on a shaft were ground from the forging to the finished dimensions. This attachment, which is illustrated in Fig. 2, also oscillates in its movements and grinds to very close limits of accuracy all cams from 2 to as many as 24 on a single shaft, in accordance with the generated shape of the master cams.

Since this device was developed very little change has been made in its form but its accuracy, alignment and rigidity have been greatly improved so that today a whole camshaft having 12 individual cams integral with it is ground in about the same time as one individual cam by the original method.

Most automobile pistons are relieved around the wrist-pin hole, while a few makers desire an elliptically shaped piston to allow for heat expansion. This is accomplished with a loose cam or similar form of oscillating attachment. The relief or elliptical shape is reproduced from a master cam within the case at the side of the driving mechanism. By this method reliefs are ground in pistons at the rate of from 125 to 175 pistons per hr., while from 40 to 75 pistons that are elliptical throughout their entire length are produced per hour, depending upon their requirements for accuracy and finish.

Square and other shapes having a flat surface with connecting arcs and radii as shown in Fig. 3 are now ground in attachments similar to that used for relieving pistons, as well as the attachment for automobile cams illustrated in Fig. 2.

With this method a square end on a transmission shaft measuring 1 in. square and 3 in. long can be ground at the rate of 65 pieces per hr., removing 0.020 in. of stock from the diameter to within a total limit of 0.001 in. for

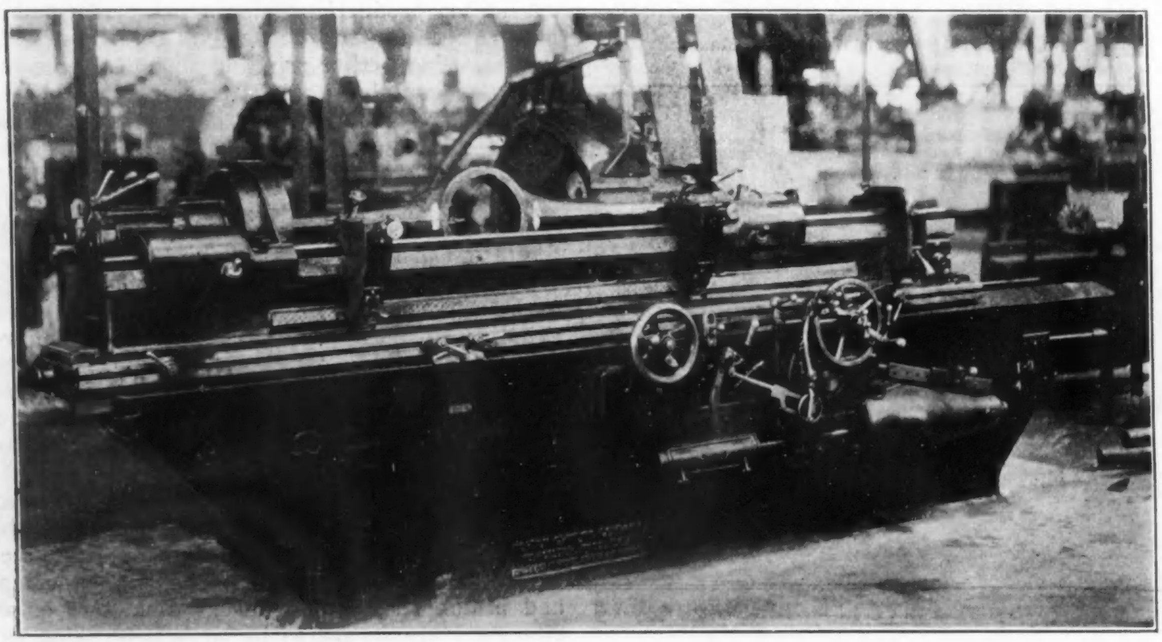

FIG. 4—GRINDING A REAR-AXLE HOUSING HAVING A LONG STRAIGHT BEARING ON EACH END

square, diameter and flat on all surfaces, the limit on the flat surfaces being from flat to 0.001 in. concave. This is a 90-per cent increase in production over the old method when using cup wheels and a hand-operated indexing mechanism. Many automobile companies have adopted this new method for grinding squares on transmission and pinion shafts, as well as brake cams for their rear axles.

Use of the Wide-Face Wheel

The principal development in production grinding during the last few years can be attributed directly to the application of the wide-face grinding-wheel in its many phases. The automotive industry is largely responsible for its introduction and advancement. This method was used widely during the early stages of the World War for form-grinding shrapnel and other shells.

One of the best and most profitable examples is shown in Fig. 4. This is a common rear-axle housing with a long straight bearing on each end, which requires not so much a reflective finish as it does a round and straight bearing. To accomplish the work satisfactorily a new steadyrest has been employed which has overcome many difficulties encountered in holding this class of work round, as well as made it easier to grind heavy and out-of-balance pieces more accurately.

The feature of this rest that distinguishes it from the rest formerly used is the independent control of the horizontal and vertical motions of the work-shoes. The previous rests were fitted with one shoe that had to be discarded when the fixed arc had worn oversize. With independent motions of the work-shoes, as in this rest, the shoes give much longer service by virtue of a generous allowance for wear provided by their adjustability.

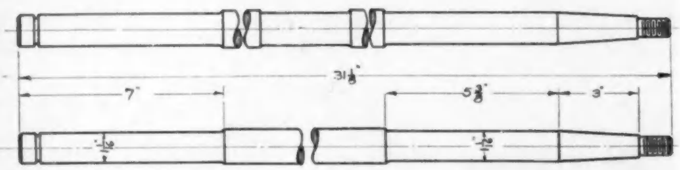

Fig. 5—Two Drawings of a Rear Axle That Is Finished by Grinding

In the Earlier Type Shown in the Upper Drawing a Flat Spot at the Center Served as a Steady-Rest While the Ends Were Ground with a Narrow Wheel. The Lower Drawing Shows the Form Now Used and Ground with a Wide-Face Wheel

Housings such as that shown are now being ground on each end by the full-width wheel method at the rate of 20 and 21 pieces per hr., removing 1/16 in. of stock to limits of 0.0010 in. for diameter and 0.0005 in. for roundness. This is done without any previous turning or snagging operation whatsoever.

Another good example of the parts produced with a wide-face wheel is the rear-axle shaft illustrated in Fig. 5. The upper drawing shows an axle with a middle spot used in the old days as a steadyrest spot to prevent vibration while the narrow wheel ground each end. Production was 12 ends per hr.

The application of the wide-face wheel removed the necessity for the spotting operation as shown in the lower drawing and increased the production obtained in 1913 to 46 ends per hr. Today on the same axle with the introduction of newer types of heavier machine, with the two-bearing independent-shoe type steadyrest, the production has reached 800 to 1000 ends in every 8-hr. shift, which is an average of 100 to 125 ends per hr. These two examples of wide-wheel grinding are sufficient to show the advantages when applied to work not wider than 9¾ in. on the ground portion.

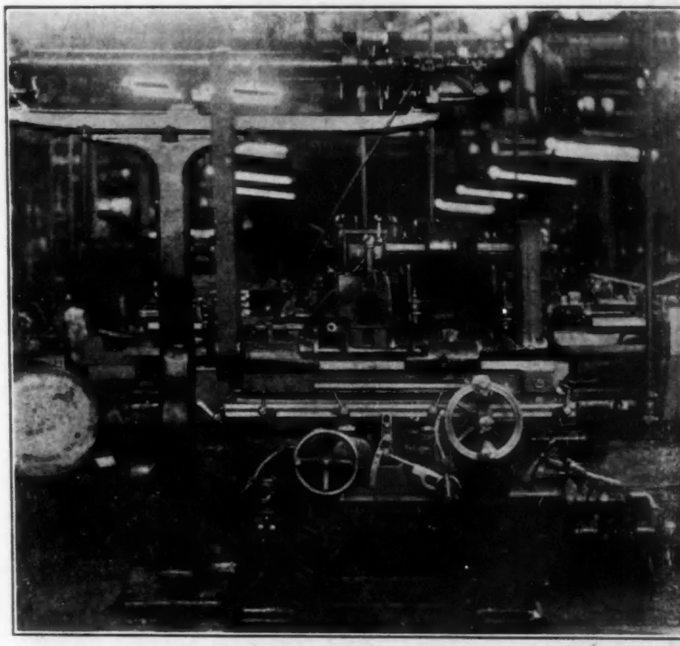

Fig. 6—Grinding a Steering-Knuckle

Special Attachments

During the last year a device known as the wheel-spindle reciprocating attachment has been developed and supplied to automotive plants. When using the wide-wheel method of grinding, before the development of this attachment, it was necessary for operators to move the work-table backward and forward by hand to break-up the grain lines in the work. This movement of the work across the wheel also served to keep the cutting-face wearing evenly. Both of these functions are now performed by this attachment, the use of which has decreased the number of truings required and the manual labor on the part of operators, increased the production and improved the quality of finish.

Great interest has been shown in the grinding of several diameters at one draw-in or straight-in cut, using two or more wheels mounted on a single wheel-sleeve.

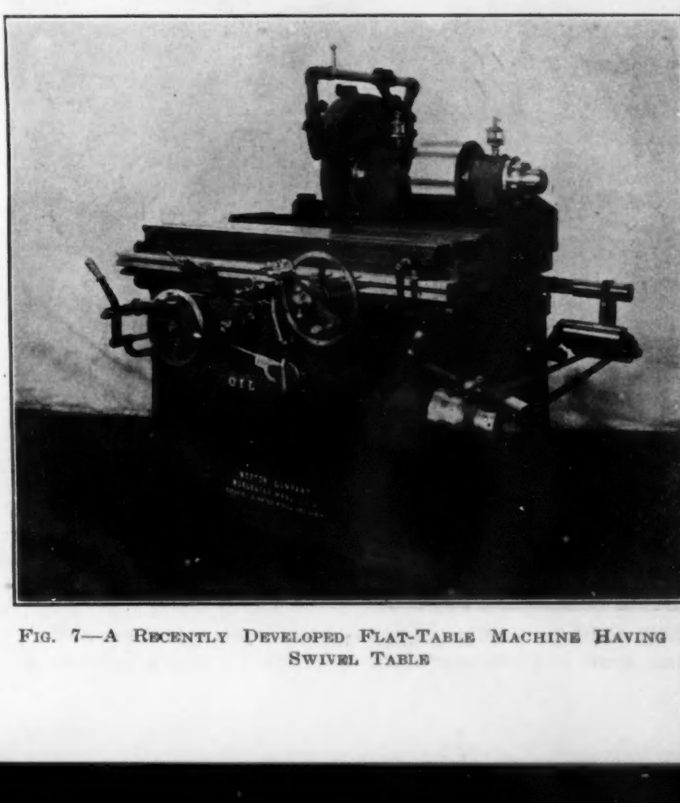

Fig. 7—A Recently Developed Flat-Table Machine Having a Swivel Table

When so equipped the machine is prepared to grind such work as steering-knuckles, pinion shafts, some transmission shafts, small differential-case bearings and such work where protrusions separate two or more short diameters.

Fig. 6 is reproduced from an actual photograph of steering-knuckle work being performed in one of the large automobile-axle plants. In the former days when

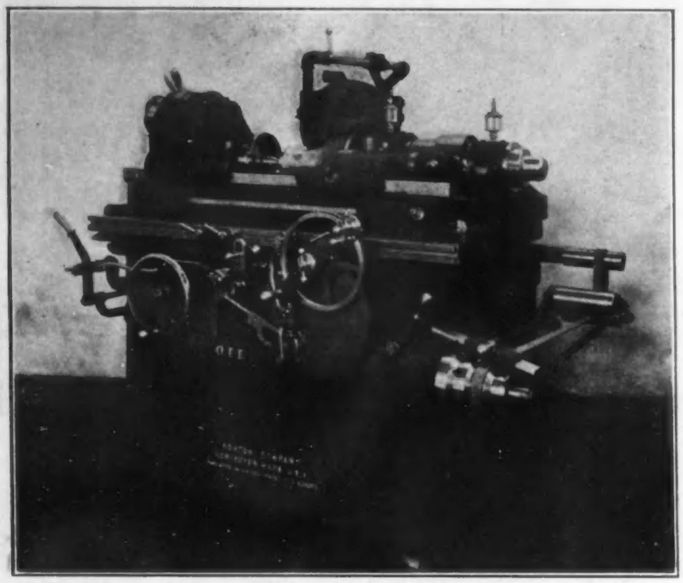

Fig. 8—Machine Equipped with a Special Adjustable-Speed Live-Spindle Headstock Grinding Pistons

one diameter was ground at a time, the hourly production was 50 complete knuckles. By the application of this new double-wheel method the production has been increased to 95 complete knuckles per hr. To accomplish this a special truing-ring with positive stops has been applied to the wheel-feed gear and each stop set for

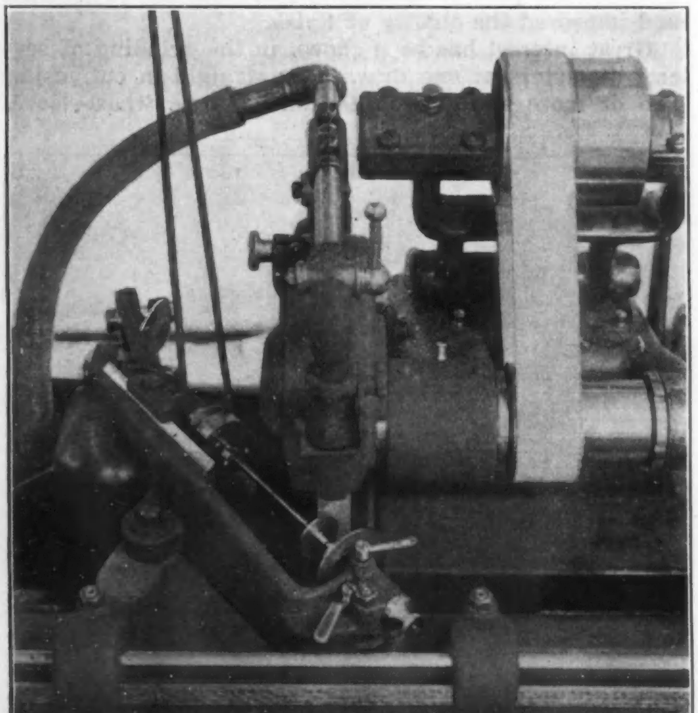

Fig. 9—Valve Face Grinding Attachment

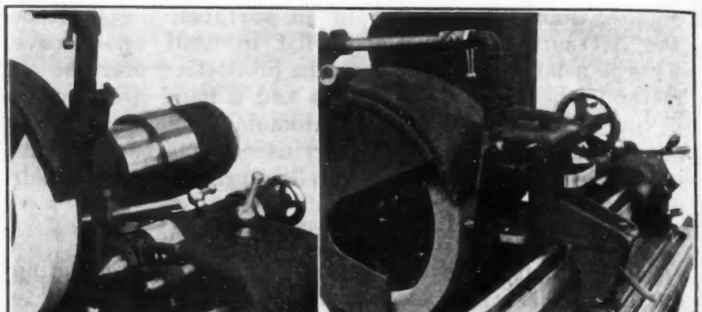

Fig. 10—At the Left a Radial Wheel Truing Attachment and at the Right a Wheel Forming Device

truing its own wheel. When both are trued to their respective diameters, a third stop is used as a positive in-feed locator for exact sizing. Many automotive plants have adopted this method of double-wheel grinding for work where this method is effective.

Grinding-machine companies have designed and built their machines with special-shaped tables, believing that in their respective particular shapes were to be found great advantages of rigidity and of retaining the correct alignment between the centers of the headstocks and

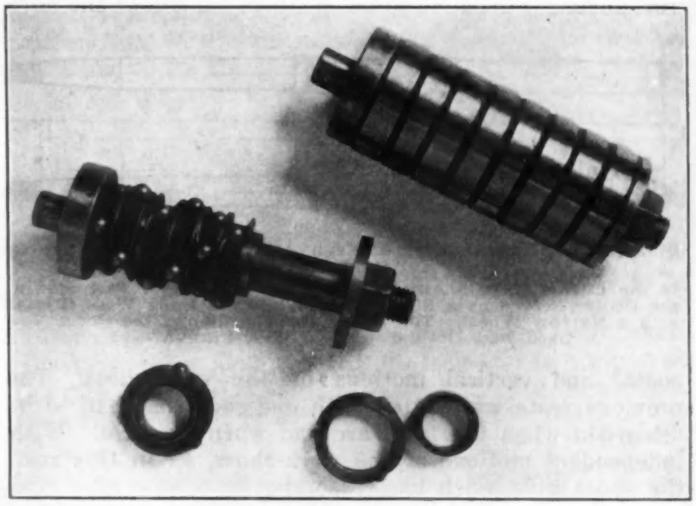

Fig. 11—A Special Arbor for Grinding the Rings of Ball and Roller Bearings

footstocks. This made it difficult for them to design suitable special fixtures for special grinding jobs.

In the last year flat-table machines have been developed that consist of a swivel table made to a height to accommodate a user's special requirements. One of these machines is illustrated in Fig. 7. During the same period the grinding-machine builders have been requested to produce certain other special attachments to enable their customers to secure a larger production of certain kinds of work that can be finished best by grinding. One of these special attachments is an adjustable speed live-spindle headstock that is used for grinding such work as pistons and other open-end pieces and differential cross-members. When grinding pistons on this attachment as shown in Fig. 8 the face-plate is removed and a special cone driver screwed into its place. The pistons are then ground at the rate of 75 to 90 pistons per hr., depending upon the degree of accuracy and finish required.

The attachment illustrated in Fig. 9 was developed for attachment to regular machines for grinding seats on

valves. Adjustments for the length of the stem as well as the degree of taper on the seat are provided. A special feature of the attachment is the provision that has been made for grinding on centers, although other attachments of this same form are fitted with collets to grip the valve-stems.

Many of the makers of crankshafts have insisted upon very accurate round fillets at the ends of crankpins and bearings. A device for forming a radius on the grinding wheel and also for truing the face of the same wheel is shown at the left of Fig. 10.

Certain jobs having a taper and several straight diameters can be ground best with the wide-face wheel. The

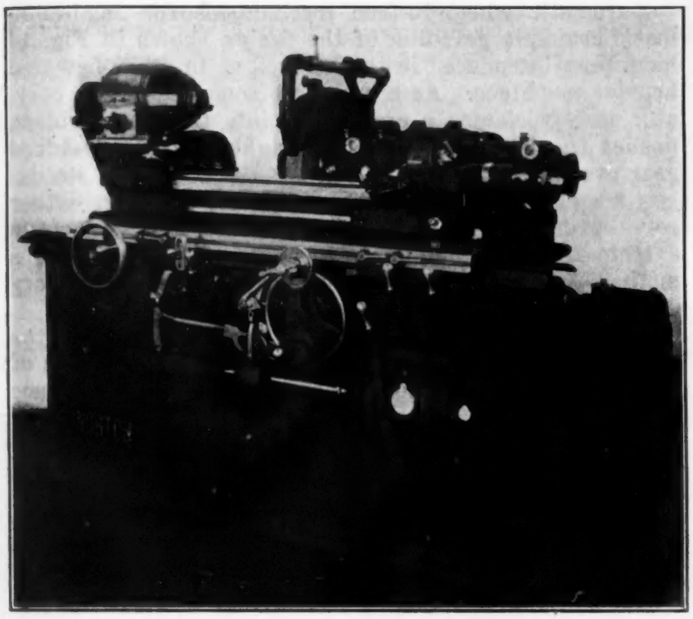

FIG. 12—A SELF-CONTAINED TYPE OF GRINDING MACHINE EQUIPPED WITH A POWER TABLE TRAVERSE FOR HANDLING OIL-TUBES, ROCKER-ARM SHAFTS AND SIMILAR WORK

forming device illustrated at the right of Fig. 10 has been developed to form the wheel for grinding an entire surface, including tapers or straight portions. The form of the wheel face is generated from a form-bar that is located directly in back of the roller. The operator places the attachment on the table in front of the wheel

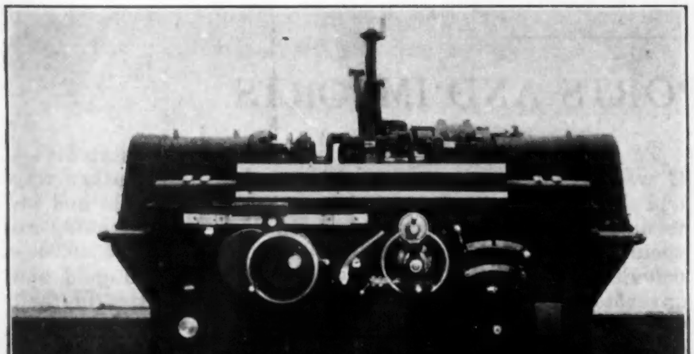

FIG. 13—CRANKPIN GRINDING MACHINE

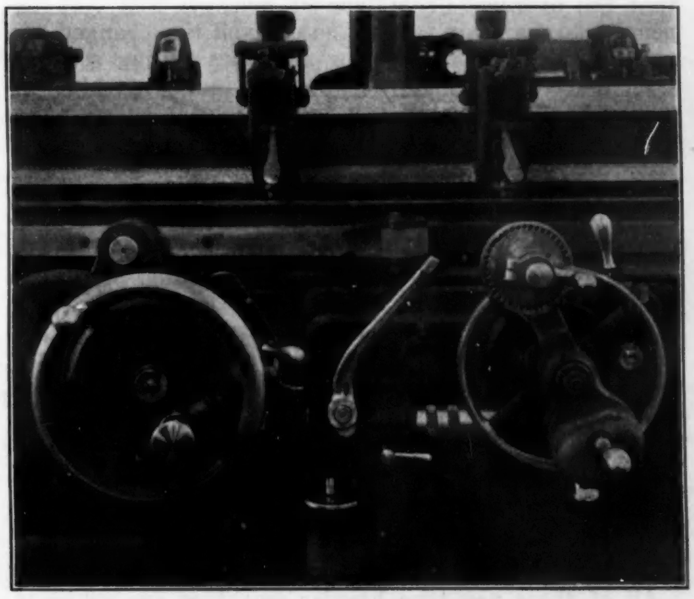

FIG. 14—THE AUTOMATIC WHEEL IN-FEED MECHANISM OF THE MACHINE ILLUSTRATED IN FIG. 13

which is brought into contact with the diamond. He then turns the handwheel, moving the diamond across the face of the wheel, following the outline of the form-bar and reproducing it on the wheel face. Since the introduction of this device the production has been increased from 100 to 400 per cent in a great many instances.

In ball- and roller-bearing work special arbors of the type shown in Fig. 11 have been made for holding as

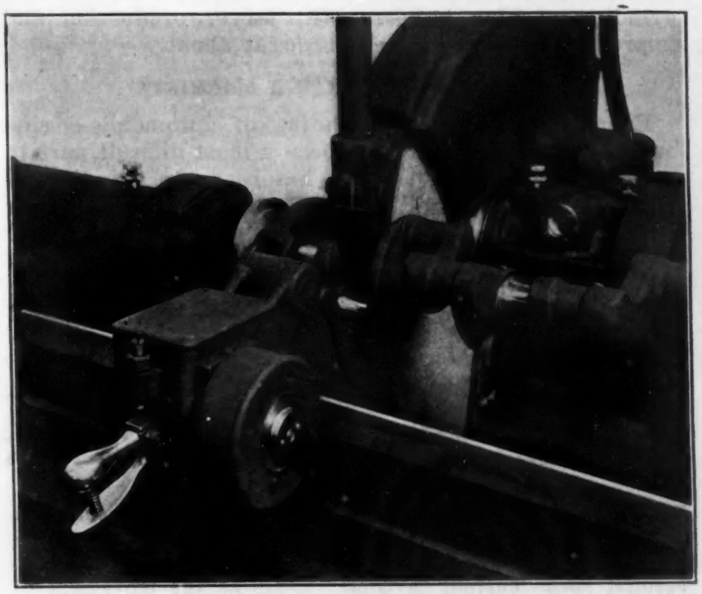

FIG. 15—THE AUTOMATIC STEADY-REST USED ON THE CRANKPIN GRINDING MACHINE

many rings as can be covered by the wide-face wheel, not over 10 in. wide. By this method production has been increased from 100 to 400 per cent over what was formerly attained with narrow wheels. In addition to this the wheel-spindle reciprocating device has been applied to the machine. This addition improves the quality of the work, increases the production and reduces the wheel cost.

SPECIAL MACHINES

For several years the automobile companies have made a careful study of machine maintenance and have said

that the overhead-drive type of machine was very expensive to maintain. Now the demand has changed and requests have been made for machines having self-contained drives and controls. The grinding-machine industry has brought out new types of machine with this thought in mind and also with the purpose of still greater production of good work at less maintenance cost. Fig. 12 shows the very newest self-contained development, which is arranged for power table-traverse drive for such work as oil-tubes or rocker-arm shafts having a larger ground diameter than could be covered by a wide wheel.

Another special-purpose machine has been developed in which the grinding is done on the extreme right end for such work as axles, drive-shafts, pinion shafts, sleeves and other parts where the wide wheel is the most productive. For all short work a short, stiff, compact machine equipped with the wheel-spindle reciprocating attachment and the power in-feed attachment that is used for automatic straight-in feed of the wide-face wheel that covers the entire surface of the part being ground has been brought out.

All of these new-type heavier machines are equipped with new mechanisms for driving the wheel. The wheel spindle is driven by a belt from the power shaft, enclosed in the base, and running in self-oiling ball-bearings. The wheel-spindle bearings are of a new and improved type and are lubricated by a constant stream of oil, forced through the bearings by a pump. Their adjustment is so simple that the operator can overcome all looseness by simply turning the thumb-screws while the spindle is running.

I have mentioned these features because it is through these new and improved designs on the part of the grinding-machine builders that larger production and improved quality have been brought about.

Crankshaft Grinding Machines

Ever since the very beginning of automobile-engine building, the crankshaft has been a most difficult part to machine. The last operation has been the grinding of the crankpins and the great difficulty has been to finish these pins round and straight to within small limits of accuracy, practically free from any imperfection. Considerable difficulty has been experienced in obtaining the required accuracy, and it is remarkable how successful the makers of crankshafts have been with the machines given to them for their use. Every grinding-machine builder has done his best to make machines that would produce crankshafts satisfactory to the trade, but more or less trouble in obtaining a satisfactory product has always been experienced. In the last 2 years still newer types of machine for grinding crankpins have been developed and installed in a number of automobile factories. These employ a new method of driving the work-spindles and eliminate the use of gears.

The machine illustrated in Fig. 13 has met the demands of the automotive industry for a complete self-contained unit. The ground product has been greatly improved and the production considerably increased over that from older types of crankpin-grinding machines.

Automatic wheel in-feed mechanisms for semi-automatic crankpin grinding of the design shown in Fig. 14 have been introduced in this as well as in other new and heavier machines. As a result, in some places the operator merely clamps a crankshaft into the work-holders, pushes the lever shown at the right of the wheel-feed gear over to the right, and releases the automatic steady-rest-lever illustrated in Fig. 15. The pins are either rough-ground or finish-ground automatically with from a 15 to 25-per cent increase in production over previous methods, with less wheel-cost and a very satisfactory finished product.

The machine shown in Fig. 13 can be said to meet the demand for smoother running machines for this class of work and the traditional belief that gears produce chatter-marks has been considered. The gears have been replaced with a silent-chain running from the lower drive-shaft to the table drive-shaft and other chains from both ends of the table drive-shaft to each revolving spindle. Where these machines have been adopted there have been *no* complaints of chatter-marks in the crankshaft.

The automotive industry has become so huge that it must be regarded as the chief element of machine-tool business and the principal factor in forcing new developments in machine-tool design and construction. Competition among builders of internal-combustion engines constantly calls for greater production and machines of greater precision. The desire of those most interested in furthering developments along the grinding line is to originate, instead of to copy some of the present achievements. To copy is not progressive; to originate is to progress.

OUR "INVISIBLE" EXPORTS AND IMPORTS

FOR 1922 there was due us from foreign countries, from the excess of our exports over our imports of merchandise, an amount of $754,000,000. However, when we take into account such "current invisible" items as the movement of interest, remittances of emigrants, tourist expenditure, ocean freights, etc., we find that our citizens have sent to or spent in foreign countries a net balance of about $425,000,000 more than we received on such accounts, and thus the balance due us arising from merchandise is reduced to about $329,000,000. As affecting this sum we have received about $246,000,000 net gold and silver imports and in addition there has been the invisible movement of loans and credits. We have exported capital in the shape of purchases of foreign securities, etc., over and above the imports of capital of the same character, to the net amount of about $669,000,000 in the year 1922, and were there no previous obligations to be accounted for this would amount to an investment abroad of more than the amounts due to us.

To visualize the full balance-sheet it might be stated that if we had entered the year with no obligations either way and if we had settled our balances in foreign trade and international finance every month in the year in gold, we should have exported gold to the amount of nearly $340,000,000 during the year, instead of having imported gold and silver to the amount of $246,000,000. As a matter of fact, the movement of our capital during the year was, as shown from the detailed study, partly a transformation of accounts due to our merchants and banks at the beginning of the year into bonds and funded debt during the year and partly a reinvestment abroad of amounts due us for merchandise sold during the year. No statement, however, as to the precise interaction of "invisible movements" can be considered in any other light than as illustrative of their relative importance, as from the very nature of things no set-offs can be stated in precise terms.—Herbert Hoover, Secretary of Commerce.

Motor-Truck Radiator-Design

By R. S. Wentworth[1]

SEVEN requirements appear to be the minimum number dictated by the necessity for greater reliability of truck radiators. They are offered as a means of analyzing past performances and indicating future changes in design. The value of the requirements lies not so much in the recognition of any single one as in compliance with the entire number. Since each requirement is essential in meeting certain definite conditions and since any one or more of these conditions might occur in the reasonable operation of any truck, no requirement may be neglected.

A radiator is strong and satisfactory only to the degree that it has no weaknesses, because it is these weaknesses that prevent the average radiator from being well balanced and strong. If the application of these requirements is made correctly, I feel very confident that radiator repairs can be reduced to an almost negligible quantity in any service for which the truck is intended. Thus, in discussing the general requirements for radiator reliability, I mention a minimum number that I believe must be observed, and I think it is essential that the designer recognize all possible stresses and their effects, even though he considers them of minor importance. Frequently, the sum of two small stresses exceeds the magnitude of a more obvious stress for which provision has been made, and I believe that this, rather than inherent frailty, has been the cause of most of the trouble experienced with radiators.

The Seven Requirements

(1) The radiator shall be designed and supported so that distortions of the frame shall not cause stresses within the radiator

(2) The raditor frame, shell or casing shall be structurally strong to withstand both internal and external stresses. The top, the sides and the bottom should form a unit of rigid construction holding the more delicate parts without transmitting twists or other strains

(3) Vibration of the tubes or any other part of the radiator shall be controlled and reduced to a minimum

(4) The radiator must withstand the effect of all possible temperature conditions without being subjected to undue stresses in any part

(5) The maximum possible stress on any tube joint shall be low

(6) Complex or indeterminate stresses in the tube joints shall be avoided

(7) Soldered joints shall be designed correctly and have ample bearing surfaces

Regarding (1), no truck frame is immune from twisting and no radiator has the characteristics of a cross-member. The designer should recognize these conditions by his choice of position and means of mounting. Many examples will be found in old trucks where frame stresses are transmitted to the radiator to such a degree that it is impossible to keep it from leaking without changing the method of mounting.

In reference to requirement (2), many instances occur where insufficient rigidity of the frame is caused by improperly designed side-pieces, poor choice of material or too light construction generally. When such radiators are subjected to rough usage, the strength of the core is called upon to do work for which it was not intended and failure is a certainty at the tube joints and elsewhere.

Vibration, (3), is a sure sign of uncontrolled stresses, a cause of trouble and a source of fatigue in any metal. While the amplitude of the vibration of the tubes may not be great, the force often is very large and the joints soon fail through repeated stresses of tension and compression that reach a maximum when the tube joint is bent. Therefore, it is imperative that the designer control vibration well within the limits of the strength of the solder joints. Tube vibration is affected by the choice of material, bracing, section, diameter and header-plate characteristics.

Concerning (4), in radiators of the heavy-duty type comprising cast top and bottom tanks spaced by rigid side-pieces, a great opportunity exists for temperature changes to alter the relative lengths of the core, the tubes and the side-pieces and thus impose high tube stresses on the header-plates. In such designs, the height of the core equals that of the side-pieces when bolted together at room temperature. Failure occurs most often in very cold-weather operating with such heavy loadings as to necessitate low-gear work and a high water-temperature. The result of these conditions is that the brass tubes of the core increase in length with a rise in the temperature from approximately 70 to possibly 200 deg. fahr., a change of 130 deg. fahr., while the side-pieces are shortened by a drop to the air temperature, a possible change in the temperature being 50 deg. fahr. or more.

These changes in the length must either cause the headers to bend or crack, the core to be compressed or the tube joints to fail; but, in any case, the stress is imposed on the soldered tube-joints in the headers. The designer of this type of radiator is cautioned against disregarding the effects of the temperature on the score of unimportance, for, though the actual distance through which the headers move may be very slight, the stress per tube runs very high and this is the dangerous condition to be avoided.

In regard to requirement (5), solder has not the qualities necessary for withstanding great stresses or repeated small ones. Good practice is to divide the total load equally among all the tubes; when this is done, the strain per tube can be handled easily and the factor of safety will be large.

To comply with requirement (6), the design should confine the stresses to tension or compression. Where complex stresses are permitted, it is most difficult to estimate their magnitude. Complex stresses occur if the headers are allowed to bend, the tubes to vibrate or the whole radiator to weave. Many incorrect designs are in use which use light headers that fail because of the joint angularity caused by the weight of the core, the temperature conditions and the proximity of the tubes to the rigid tank, together with the stiffening effects of the solder on the headers and the loss of flexibility of light headers when bolted firmly to the tanks. It is interesting to note the preponderance of leaks on the outside rows of radiator tubes, caused by these tubes being subjected to more conditions than the inside tubes, and justifying, to my mind, the necessity for recognizing *all* controlling causes.

The design of the soldered joints, (7), the properties of the solder and correct manufacturing methods are understood by the better class of radiator manufacturers. The joints should be amply strong to avoid failure caused by production methods and hard usage.

Summary

As long as designers fail to provide for the effects of all possible conditions, the radiators they design must fail in service eventually. The more logical procedure is to provide individually for each possible stress, so that it cannot cause trouble alone or in combination with the other stresses. For example, since the bad effects of frame weaving, tube

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vibration and temperature changes are added together under certain conditions, the engineer's problem is to produce a design that shall be able to withstand the effect of the sum of any combination of adverse conditions. If this is done, the result will be a radiator having no weaknesses and therefore possessing great strength. To expect a commercial product of engineering so free from inherent weakness that the life of each component will be the same, and the final failure from old age will occur anywhere and everywhere in a general collapse, is not asking too much.

THE PETROLEUM INDUSTRY

THE recent drastic reductions in the prices of gasoline are the natural consequences and expression of a situation that has been in process of development for at least 2 years. The over-production of oil in this period and the resulting accumulation of stocks of crude petroleum and its products have been regarded with growing concern. Although the present "price war" began with the retailing of gasoline by an official of a Western State, there has been ample evidence that a general fall in oil prices was imminent.

Clearly, relief must be sought either in a reduced production of crude oil or in an increased consumption of oil products. For many reasons the most desirable means of accomplishing a curtailment of output would be voluntary, concerted action on the part of the producers themselves. But the type of organization that prevails in this branch of the industry makes such a solution virtually impossible, and the necessary reduction of output will probably come as a result of extremely low prices, making the operation of many wells unprofitable. Restriction of purchase by the refineries may offer the most immediate and effective means of curtailing crude oil production with a minimum of embarrassment for all concerned.

From the standpoint of the public, restricted purchasing by the refineries would appear to be preferable in the long run to the price-cutting that has actually taken place. Any excessive reduction in the prices of petroleum products is unfortunate in that it unduly stimulates consumption and hastens the depletion of the already rapidly disappearing resources of the Country. This point has a more important application at present than may at first appear, since a lowering of prices promptly induces changes in habits of consumption and of adoption of equipment for the use of oil products which permanently affect the demand.

The prodigality with which this Country's oil resources have been exploited has not been sufficiently recognized. Out of an original estimated reserve of something like 15,000,000,000 bbl. already at least 6,400,000,000 bbl. have been extracted. And the rapid growth of the industry in the last few years increases the gravity of the situation. If the rate of production that prevailed for the first half of this year should be maintained, the estimated supply would be exhausted in 12 years; while if output should increase at the average rate of the last 3 years, 1931 would see the end of our oil resources.

Fortunately, this situation is not likely to arise, for the physical conditions under which production is carried on are such that the maximum rate cannot be maintained. The peak of the production of each well is reached very early in its life, and the flow of oil gradually diminishes until its exhaustion. Even with the discovery of new and rich deposits in California, the acceleration of output has been accomplished only by the sinking of an enormous number of new wells. On Dec. 31, 1922, there were approximately 284,880 producing oil wells in the United States, operated by about 5000 individual owners. This compares with 258,600 wells in 1920, 203,000 in 1918 and 169,000 in 1913. Outside of California the average rate of production per well declined from 1920 to 1922 in every field except one, the Lima, Ind., where it remained stationary.

The plan of a typical field has been compared to a checkerboard, each square representing an individual claim. These holdings, which are not infrequently as small as 10 acres each, overlie a common pool, or reservoir, of oil. As every gallon extracted by one well reduces the potential production of those surrounding it, the drilling develops into a race in which each producer tries to get the oil before someone else gets it. This situation has two important effects. The first is a strong inducement to the competing producers to extract the oil with the greatest possible speed, an inducement that only a ruinously low price of crude petroleum could remove. The delicate adjustment of supply to demand that is a feature of most competitive industries is destroyed, and the production of crude petroleum continues unchecked in spite of the immense stocks accumulating in the tanks of pipe-line and refining companies and the heavy reductions in the prices of crude and of refined products. The second effect of this competition in oil production is the waste occasioned by the loss of pressure. Oil generally occurs in close association with gas under high pressure, which materially lessens the difficulties and expense of extracting it. This pressure, of course, is never of sufficient duration to force all the oil to the surface; but, under the most favorable conditions, it frequently continues for long periods. Obviously, the "punching" of the pool at thousands of points results in a very great waste of pressure and not only advances the stage in which the product must be pumped to the surface at a considerably increased cost but makes impossible the recovery of some of the oil that might otherwise be available.

Although pipe-lines have been held to be common carriers under the jurisdiction of the Interstate Commerce Commission and as such are under obligation to accept and transport oil belonging to others, as a matter of fact the pipe-line companies buy most of the oil outright at the fields. Pipe-line carrying rates and the prices paid for petroleum at the wells have usually been such as to make it more profitable for producers to sell their oil at the wells than to transport it any considerable distance.

Early in 1922 David White estimated the reserve supply of the world at 70,000,000,000 bbl. and that of the United States at slightly more than 9,000,000,000 bbl. This means that in 1921 this Country's supply was being depleted at an annual rate of more than 5 per cent, and that the rest of the world at less than 0.5 per cent. The increased production and the shrinkage of the reserves in the United States since 1921 would, of course, make the present rate of depletion even more striking.

Nothing in this condition should occasion immediate alarm. The worst that may be expected in the measurable future is an increasing reliance by this Country upon foreign oil reserves and ultimately higher prices. Fortunately, the known world deposits are ample for prospective needs for many years to come, and future discoveries may add greatly to the available resources. Meanwhile, against the rapidly expanding requirements may be placed possible new processes and inventions that would introduce hitherto unknown economies in the preparation of petroleum products and in their utilization. These considerations do not, however, justify a heedless and premature exhaustion of a leading natural resource, but indicate the necessity of a progressive adaptation of the industry to the Nation's current economic requirements with a reasonable regard for the welfare of future generations.—*Guaranty Survey*.

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Some Notes on Brake Design and Construction

By H. M. CRANE[1]

METROPOLITAN SECTION PAPER *Illustrated with* CHART

BRAKES have three functions: (*a*) maintaining a car at rest, (*b*) reducing the speed of a vehicle or bringing it to a stop, and (*c*) holding a vehicle to a constant speed on a descending grade. The kinetic energy of a moving vehicle is directly proportional to the weight of the vehicle and to the square of its speed. The amount of heat produced in the braking surfaces of a vehicle descending a given grade for a given distance will be the same whether the speed be high or low, but the rate of heat production will vary inversely as the speed. In addition to the retarding effect of the braking system a braking effect is constantly present that depends on the tractive resistance of the vehicle at various speeds and on the engine itself. Wind resistance and the resistance of the engine when the throttle is closed also produce retarding effects that assist in the work of braking.

Among the desirable features that should be kept in mind in designing brakes are (*a*) the maximum retarding effect with reasonable physical effort on the part of the driver, (*b*) smoothness of retardation, (*c*) a retarding effect proportional to the pedal pressure, (*d*) no tendency to be self-locking, (*e*) durability or long life, (*f*) ease and simplicity of adjustment, (*g*) strength, easy operation and thorough dependability and (*h*) brake-operating levers that may be easily and quickly reached in emergency.

The power available for operating brakes is a pedal movement of 4 to 5 in. coupled with a foot pressure that varies with the person operating the brake; consequently, brakes should be designed for the weakest driver. A properly designed mechanism will sometimes accomplish the same result with one-half the pedal movement that is required by another linkage of the same type but of inferior design. The linkage should be simple and direct, and the relation of the centers of the connections that operate the brakes on the axles and the wheels should be carefully studied so that the relative motions of the axle and the frame will not affect the linkage. If the major part of the multiplication of leverage takes place at the brake-drum the strains in the operating mechanism will be reduced to a minimum and the longitudinal motion will be increased to a maximum. In any design the two points to be kept in mind are a low rate of wear and a high rate of heat dissipation. In general, large linear dimensions are desirable but better air-circulation sometimes makes smaller sizes preferable. In light cars weight is of importance, while in heavy cars size is the controlling consideration. Unit pressures depend largely on the materials used; a brake-drum with hard surface with a lining of suitable material may enable higher unit pressures to be used than a soft surface with a lining inherently weak. Most brakes depend on either the external or internal application of shoes or bands. The features of the band type are light weight and a large friction-area. The external band is easier to design as the anchor point can be placed in any position desired. To obtain smooth action and long wear from a shoe-type brake, rigidity of both the drum and the shoes is essential. The balance of advantage appears to be in favor of the contracting-band brake, especially when the travel is over hard-surface roads. The requirements of braking materials are that the drum be as hard as is commercially possible and retain its hardness when heated, while the brake-lining should be close-grained and hard with a uniform coefficient of friction throughout its life.

MUCH of the difference of opinion that invariably appears when automobile brakes, or braking systems, are discussed undoubtedly arises from the widely different services required of such brakes, or braking systems, under varied conditions of use. For this reason, it appears to be worthwhile in starting a further discussion of this important subject to summarize briefly the more important functions of brakes.

BRAKING FUNCTIONS

Probably the simplest of these functions is to maintain the vehicle at rest on a level surface or on a grade; another function is to reduce the speed of a moving vehicle or to bring it to an absolute stop, either on a level surface or on an ascending or a descending grade; still another function is to cause the vehicle to maintain a constant speed on a descending grade. The first function mentioned, that of maintaining the vehicle at rest, obviously is the simplest one. The main requirement is that of multiplying the leverage from the operating lever to the braking surface, and of combining it with the leverage relation of this surface and that of the road wheels and with the two coefficients of friction, so that it shall be sufficient to lock the wheels under all conditions. As there is no motion involved in this case, no heating conditions need be considered and no particular smoothess of operation or resistance to wear is required; and even inaccurate connections between the frame and the axle may not cause trouble. As soon, however, as the vehicle is in motion and the braking system is in use, a very different set of conditions exist that requires the highest skill of the engineer in order that a satisfactory arrangement may be produced.

In this discussion, I shall consider only the ordinary type of brake in which a stationary surface is pressed upon a moving surface driven by the vehicle wheels, with the result that the energy present in the moving vehicle or produced by the descent of the vehicle from a higher to a lower level is translated into heat by the friction between the relatively moving surfaces. The energy present in any moving vehicle, of course, is directly proportional to the weight of the vehicle, as is also the energy given up during the descent of the vehicle from a higher to a lower level. The energy present in a moving vehicle due to its speed is proportional to the square of the speed.

The maximum force of retardation possible is pro-

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portional to the weight on the wheels to which braking is applied and to the coefficient of friction between the tires and the road surface. The rate of retardation will be proportional to the percentage of the total vehicle weight carried on the wheels to which braking is applied. In view of the fact that the rate at which heat is produced at the braking surfaces has a very important bearing on design, it is well to remember that, though the amount of heat given out during the descent of a vehicle for 1 mile on a 10 per cent grade at any rate of speed will be the same, the time during which the heat is produced will vary inversely as the speed. The same holds true with regard to reducing the speed of a car from a higher to a lower rate, or bringing it to an actual stop. The principles stated above are universal in application and will not be affected by any variation of brake design or construction. It appears to be hardly necessary to emphasize this fact, except that statements are occasionally made favoring one type of brake design over another, which seems to indicate that at least some of the principles outlined above had not been kept clearly in mind.

For sake of clearness, the above principles have been enumerated as if the entire retarding effect would always be obtained by the braking system. As a matter of fact, however, a braking effect is constantly present in every moving vehicle that depends on the tractive resistance of the vehicle at various speeds and on the engine itself. The wind resistance at high speeds and the resistance of the engine, even on high gear, at all speeds, provide effects of retardation that assist very greatly in the work of the braking system. There has been more or less discussion of the effectiveness of the engine as a brake and for this reason I am glad to be able to give the results of a test recently made on a passenger-car engine of normal design, the engine in question having 4½-in. bore, 5-in. stroke, six cylinders and a piston displacement of 425 cu. in. The curves shown in Fig. 1 are taken with both the oil and the water at maximum running temperatures and can undoubtedly be translated for various sizes of engines by comparing the piston displacements. It is interesting to note that the retarding effect is considerably higher, especially at the lower speeds, when the throttle is closed, than when it is open. This is particularly fortunate, as it somewhat simplifies the use of the engine as a brake.

Desirable Features of Brake Design

In discussing the various desirable features of brake design and operation, no attempt will be made to list these features in the order of preference, but if they are not all kept in mind and each one is not given serious consideration in arriving at a final conclusion, first-class results cannot be expected. Among them are the following:

(1) *Maximum Retarding Effect from Reasonable Physical Effort on the Part of the Driver.*—Just how far it is desirable to go in reducing the physical effort required to slip the braked wheels is a question. In the case of a good driver, the least effort possible will give the most satisfactory result. In the case of unskilled drivers, however, there is a tendency to push or pull as hard as possible in an emergency and a brake that is too easily operated is liable to produce a violent skid under such treatment

(2) *Smoothness of Retardation.*—This is necessary for the comfort of passengers. Chattering or grabbing brakes reduce braking efficiency and increase the danger of skidding

(3) *Retarding Effect Directly Proportional to the Pedal Pressure.*—This is necessary to allow accurate control of the braking effect under different conditions of road surface. It can be obtained only where there is a minimum of friction, uniform friction and uniform spring throughout the brake-operating mechanism

(4) *No Tendency to Be Self-Locking.*—This is, to some extent, another way of stating the previous requirement. It is not exactly opposed to brakes of the wrapping type, although it is very difficult to design such brakes without some of this undesirable feature. It is intended to apply more directly to mechanisms that have a tendency to jam under certain conditions, which makes it difficult to reduce the braking effect without almost completely releasing the brake and reapplying it

(5) *Durability or Long Life.*—The result of this is shown in the infrequent necessity for replacement of friction surfaces and the correspondingly infrequent adjustment

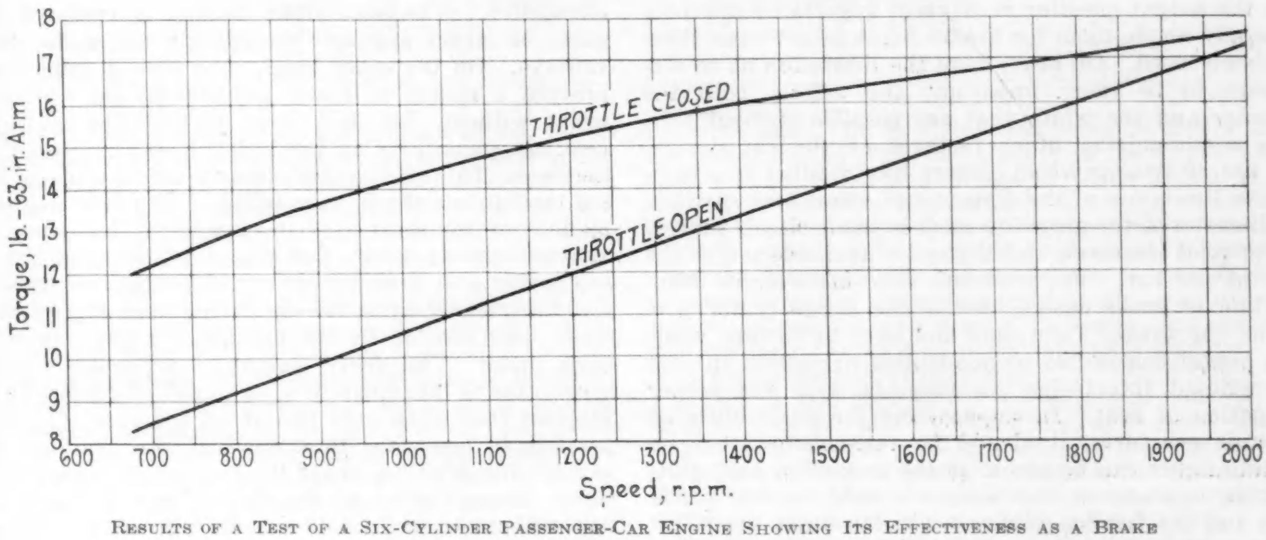
(6) *Ease and Simplicity of Adjustment When Adjustment Is Required.*—Uniform action under all conditions, that is, the retarding effect, must be maintained throughout long and severe brake applications and must not be altered materially by weather conditions or outside causes. Of course, the latter point refers only to the brake mechanism and cannot be controlled as regards the road surface

(7) *Need for Strong Locking Devices for Brakes.*—The locking device for the hand brake, or other car-locking brake, must be strong, easily operated and thoroughly dependable. This locking equipment is really a safety device of great importance and when inefficient has been the cause of serious accidents

(8) *The Brake-Operating Levers Must Be Easily and Quickly Reached in an Emergency.*—This applies equally to the foot-pedal, which ordinarily operates the service brake, and to the hand-lever, which operates the so-called emergency brake. As a matter of fact, in current practice, the foot-pedal is the real emergency brake, the hand brake being used only when the foot-operated brake fails to produce the desired result. This being the case, it is obvious that the greatest care should be taken to place the foot-pedal in a position that can be reached with a minimum of motion and a maximum of certainty. This requires careful consideration of its relation to the accelerator pedal, with a view to making the transition of the foot from the accelerator pedal to the brake pedal as smooth as possible, and to insuring that the operation of the brake-pedal cannot result in the depression of the accelerator pedal at the same time.

Power Available for Operating Brake

Disregarding for the moment various forms of servo mechanism, the power available for operating brakes may be stated approximately as follows: For the foot-operated brake, a pedal movement of from 4 to 5 in., coupled with the maximum convenient foot-pressure. This latter, of course, will vary with different persons, and it is desirable that the mechanism be designed for the weakest driver that may have to operate the vehicle. It should be borne in mind that the clutch is frequently thrown out at the same time that the foot-brake is operated, an act that will absorb from 30 to 50 lb. of the available force. For the hand-brake, a total motion of from 12 to 15 in. may be used, coupled with the driver's available pulling power. It is recognized that



RESULTS OF A TEST OF A SIX-CYLINDER PASSENGER-CAR ENGINE SHOWING ITS EFFECTIVENESS AS A BRAKE

greater pedal and hand-lever motions are frequently provided than those stated above, but they cannot be provided without making the brake operation much less convenient and more uncertain in cases of emergency. Of course, by the use of some form of servo mechanism, varying from the wrapping type of brake to the entirely separate mechanism in which the driver supposedly furnishes the control and the mechanism furnishes the power, almost any results are possible. There is nothing new about servo mechanism for this work. The horse-drawn Paris omnibuses of 1888 were equipped with shoe brakes pressing against the rear tires, the greater part of the power for application being provided by several turns of rope wound around bronze capstans on the hubs.

BRAKE-OPERATING MECHANISMS

This paragraph is placed directly below the preceding one to emphasize the close relation between the two. In the simplest terms, the possible pressure of a brakeshoe or band on a drum is the push of the driver's foot or the pull of the driver's hand multiplied by the total distance traveled by the driver's foot or hand and divided by the total distance traveled by the brakeshoe or band. From this must be subtracted the losses due to friction in the operating mechanism and to the lost motion and the spring in the parts. It is entirely possible for a well-designed set of brake connections to accomplish the same results with one-half the pedal movement that may be necessary in using another linkage of the same type but of inferior design. There have been too many cases in the past in which either excessive pressure has been required for a given braking effect or the actual motion of the bands or shoes has been reduced to such a point as to make correct adjustment difficult and frequently necessary. In some cases, either the brakes will not hold properly when applied or, if adjusted to do so, will drag when released as fully as possible. Some principles that have been found to be of great help in producing the best results are as follows: Have the linkage simple and direct; use the greatest care in studying the relation of the centers of the connections that operate the brakes on the axles and the wheels so that the relative motions of the axle and the frame will not affect the operation of the linkage. It is entirely possible, even with cars using the Hotchkiss drive, to accomplish this desirable result in an almost perfect manner; to do so, it is necessary to bear in mind that the axle rotates more or less because of the torque-reactions produced in braking. It has been found to be of great assistance in handling this difficult portion of design to have the major part of the multiplication of leverage take place at the brake-drum. If this is done, the strains in the operating mechanism will be reduced to a minimum, while the longitudinal motion will be increased to a maximum. Obviously, if the brake rods leading from the frame to the axle move 6 in. during the application of the brakes, the effect on braking of the variations in centers will be far less than if the motion is 2 or 3 in.

DESIGN AND CONSTRUCTION OF THE BRAKE MECHANISM

It is practically universal practice with brakes to provide a rotating cylinder that is retarded by the pressure of a shoe or band, either external or internal. Occasionally disc-type brakes have been suggested, but they do not seem to offer any particular advantage. Keeping in mind the work to be done by a brake, there appear to be two points of importance that must be worked out in the design, one being the low rate of wear, the other, a high rate of heat dissipation. Low rate of wear, other things being equal, will, of course, be obtained best by low unit-pressure between the rotating cylinder and the friction band or shoes. This requirement indicates the desirability of brakes of large linear dimensions. Large linear dimensions are also of considerable value in obtaining a high rate of heat dissipation; but it must be borne in mind that in long continued brake applications the heat dissipation will be governed largely by the ability of the brake mechanism to transfer heat to the surrounding air. For this reason brakes of small size that provide rapid air-circulation may easily be more effective than much larger brakes that are more or less shielded from the air by parts either of the brake mechanism or of the car. Large and heavy brake parts have an advantage in that they can absorb a great quantity of heat during a short brake application, the heat being gradually dissipated to the air during the intervals between the applications. As a matter of fact, the ability to dissipate heat is closely connected with the ability to resist wear, for the reason that in almost all combinations of braking surfaces the wear becomes much more rapid as the temperatures become higher. This is probably due, fundamentally, to the softening of the metal or metals used as the temperatures become higher. About the hardest problem the car designer has to face in laying out brake equipment is to decide as to the sizes and weights that can be allowed. In the lighter

cars the weight question is of great importance, as there is usually ample room for brakes much larger than those commonly used. On heavy cars the limitation as to size appears to be more important and affects both the diameter and the width that are possible without seriously compromising other features of the car design. The use of smaller wheel centers has resulted in a very definite limitation of the diameter of wheel brakes, while the diameter of the propeller-shaft brake is closely limited by the road clearance and the space available under the floor of the car. There is one very unfortunate complication in brake design, due to the necessity for protecting the brakes from mud and dust to obviate wear. It is almost impossible to accomplish protection of this sort without interfering considerably with the proper dissipation of heat. In emphasizing the desirability of low unit pressures, it should be remembered that no absolute figure can be given, as the maximum safe unit-pressure depends on the materials used in the brake-drum and the friction surfaces. If the brake-drum has a very hard surface and a suitable friction lining is used, it is possible to use unit pressures much higher than if the drum surface is soft and the friction lining inherently weak. In any case, it is highly desirable to keep the unit pressures as low as possible, both by using as large brake dimensions as the design will permit and, especially, by seeing that the pressure shall be uniformly distributed over the whole braking surface. So far as I can see at the present time, it is hardly necessary or desirable to provide 100 per cent braking for all possible conditions of service without the use of the engine. The tax would be too great on the average car user and would be merely for the benefit of the user traveling in mountainous country at fairly high speed. The engine is so excellent a brake that, under suitable conditions, it seems only reasonable to expect that it will do its share of the work.

Types of Brake-Drum and Band or Shoe Design

Design has crystallized into relatively few major variations of members; thus we find either internal or external application of either shoes or band. The general features of the band type are light weight and a large friction-area for a given size of drum. The light weight is due to the facts that with a properly designed band-brake there is very little tendency to distort the drum, and that minor distortions of the drum will not interfere with smooth brake operation. The large area of contact is due to the ability of the band type to utilize the entire circumference of the brake-drum while still providing the proper clearance when released. The external band is considerably easier to design, as the anchor point can be placed in almost any desirable position, depending upon the wrapping effect required. This is not true of the internal band, which requires that it be of the wrapping type to spread the pressure over the whole available surface. It is only the compression side of an internal band that is used to advantage, the tension side tending to pull away from the brake-drum and to concentrate the pressure at the ends. An advantage of the band type is its ability to provide almost the entire multiplication of leverage directly at the band, and the brake adjustment as well. The band brake, unless it is of fairly expensive construction, is more likely to rattle and is harder to keep from dragging than is a properly designed shoe-brake. On wheel brakes this undoubtedly interferes to some extent with the proper dissipation of heat. On a propeller-shaft brake this is not the case, as in this type it is very easy to provide internal air-circulation. The shoe-brake usually consists of fewer parts of larger size and accordingly has a decided advantage. On the other hand, it is almost impossible to provide a means of ready adjustment for a shoe-type brake without placing a large part of the multiplying leverage somewhere in the brake linkage, instead of at the shoes. This greatly increases the friction in the applying mechanism, the friction being still further augmented by that of the cams used in expanding the shoes, if an internal type is used. External contracting shoe-brakes are hardly ever used, except on the propeller-shaft. With the contracting type the operating mechanism can be made very similar to the operating mechanism of the band brake. The heavy weight of a properly designed shoe-brake is due entirely to the need of rigidity and to the fact that when only two shoes are used it is hardly possible to use more than one-half the available drum surface for friction, about 90 deg. being taken by each shoe. Though more of the circumference can be used, any attempt to do so will make it difficult to obtain the proper clearance between the drum and the shoes when the brake is released. To obtain smooth action and long wear from a shoe-type brake, the drum must be rigid enough to stay truly round, and the shoes must be rigid enough to retain their shape under the maximum pressure used. This can only be accomplished by heavily ribbing both the drum and the shoes. Another reason for the desirability of a rigid drum and shoes is the limited motion and power available for comfortable brake operation. Any spring in these parts must be absorbed before the maximum pressure is reached and is far more serious than a spring in other parts of the brake mechanism, because the maximum leverage has been provided at this point. I have suspected that a great part of the advantage of a heavily ribbed brake-drum is due to its weight and rigidity rather than to any greatly increased area for dissipating heat. The external-contracting brake, whether of the band or shoe type, has a distinct advantage over the internal-expanding brake in that the braking ability tends to improve over long continued application rather than to decrease. This is on account of the expansion of the drum and other brake parts that is caused by the heat absorbed. Of course, this applies more strongly to the present conventional brake design in which the drum is of metal, and the friction surface is asbestos fabric or some other relatively poor conductor of heat. My own feeling is that the balance of advantage is in favor of the contracting-band brake, especially in districts where the great bulk of travel is on hard surface roads.

Brake Materials

There is not a great deal to be said on this subject without going into a long investigation of brake-lining materials. There are, however, one or two important points. The brake-drum, which is ordinarily of steel, should be as hard as is commercially possible and should retain its hardness when heated. The brake-lining material should also be close grained and hard, and should have a uniform coefficient of friction throughout its life. This is highly important on all types of wheel brake, because of the fact that equalization, even when it is provided, only attempts to equalize the brake-shoe or band pressure. I have found it to be of considerable advantage to treat brake-linings occasionally with oil, in order that the binder shall be maintained in efficient shape. I have never seen any asbestos fabric that showed much cohesive quality after being completely dried out by high heat.

ST. LOUIS AIR MEETING

IT has been said truly that correct forecast of the future is rare because it must be founded upon a disbelief in the stability of things as they are. Life overleaps every bound that is set. The prime elements requisite in progress have to be sensed and developed by groups of relatively few men. The public in general is always slow to appreciate the coming of changes that affect life fundamentally.

The airplane races held at St. Louis last month formed a fitting climax to such recent events as the successful trials of the Barling Bomber; the Air Service mobilization test along the eastern seaboard; the successful trials of the ZR-1, recently rechristened the Shenandoah; the bombing tests off Cape Hatteras; the opening of the Boston airport and of the Louisville airport; the Transcontinental airplane flights; the winning of the Schneider Cup in the seaplane race at Cowes, England, by the United States Navy Team; and the night flying of the Air Mail Service from Chicago to Cheyenne. The work of engineers engaged in and in connection with aeronautics, following in the footsteps of masters in pioneer aviation, has involved almost unparalleled research connected with raw and finished material. To this is attributable the remarkable achievements of today, including speed, altitude and duration performance. Each and every part has been subjected to long and accurate tests to bring about simplicity, strength and lightness through proper distribution of material according to mechanical laws. The importance and the value of passenger and freight carriage by aircraft are self-evident. Taking into account the fact that air transportation is inherently different in basic characteristics from practically all other forms of transportation, it is probably fair to say that it is not less developed or to be debited with a greater percentage of casualties than the other mediums of transportation were after the expiration of the same number of years during which serious concerted attention has been given to commercial aircraft development. The Society of Automotive Engineers took concrete steps several years ago to establish in conjunction with the Bureau of Standards a safety code for aeronautics. Good headway has been made in the tentative formulation of this code. Various parts of the code, which deal with airdromes and airways, balloons, airships, and airplane structure, have been drafted. All of the governmental and industrial bodies interested in aviation are participating in this work, which is being conducted through a sectional committee of the American Engineering Standards Committee. The purpose is to have ready a well considered document setting forth regulatory needs and provisions when some department of the United States Government is authorized and directed to put such regulations into effect.

Responsibilities of Development and Defense

As was pointed out at the sessions of the National Aeronautic Association in St. Louis, a great responsibility rests upon those who understand what aircraft development means. In the last analysis the maintenance of adequate aeronautic activities depends, and will depend, upon the degree of aggressive spirit fostered by the public. The National Aeronautic Association can, and should, be most helpful in this connection. The Congress must have brought to its attention clearly the necessities of the Air Service. The greatest need is the enactment of legislation that will result in the enforcement of governmental regulations such as those referred to above. Of course, there should be adequate preparedness with regard to aircraft in the event of war. The development of civil air transport is absolutely essential to this.

At the National Aeronautic Association Dinner in St. Louis, Dwight Davis, assistant secretary of war, expressed cordial sympathy with the industrial work in the aeronautic field. He said that the men in the War Department realize the importance of this more than anyone else and will always cooperate fully. He predicted that complete flights across the United States from the Atlantic to the Pacific will be made between dawn to dusk and to China in 100 hr. He said that we are doing pitifully little in the way of preparing to meet successfully invasion by enemy aircraft. Congress has reduced our Air Force unduly, which has not proper equipment and less than 1000 officers. There is now an actual shortage of planes for some purposes; our most important arm of defense is being starved to death. An aeronautic industry cannot be built up overnight during wartime. Aircraft are indispensable during war.

Mr. Davis said that he did not believe in building up a large air fleet but that we should have a 10 years' program to provide a basis of procedure and give the airplane builders sufficient orders to remain in business. He stated that all of the leading nations except this Country are giving these matters close and constructive attention.

Major-General Patrick, chief of the Air Service of the Army, pointed out that we can produce airplanes that are unexcelled, and that we have the best of pilots, but that we do not really put aircraft to work. He said that the continuance of this policy would result in this Country losing much in the commercial markets of the world.

Rear-Admiral Moffett, chief of the Bureau of Aeronautics of the Navy, stated that the Navy is twice as badly off as the Army is. Referring to airship development, he said that the Shenandoah is not a copy of foreign products but was designed by Americans and made of American material. He expressed strong belief in the future of airships, stating that they can navigate with the aid of the barometer and knowledge of the weather conditions. Cruising at 60 knots, they can avoid storms. It is the intention of the Navy Department to send airships across the Atlantic, to the North Pole and around the world. The Admiral said that the Shenandoah should be able to cross the Atlantic in 2 days, and the Pacific in from 3 to 4 days. He declared that this Country has the greatest of opportunities before it in aircraft development and should proceed carefully and thoroughly in demonstrating the new means of passenger and merchandise transportation.

Commander Billard, of the United States Coast Guard, said that this Country should be second to none in National defense. The Coast Guard, which was organized in 1790, has participated in all of the wars in which this Country has been engaged, its percentage of battle losses being greater than that of any other arm of the services except the Marines. Coast Guard aviation is of direct assistance in National defense. Aircraft are the greatest agency in searching territory, which is involved in all Coast Guard work.

Brigadier General Felend, of the United States Marine Corps, said that, whereas only a few years ago the older officers merely tolerated aviators, they now consider them serious, hard-working men. This new conception puts the Army as well as the Navy solidly behind aviation. The result should be the mightiest development in any one line of human endeavor.

Second Assistant Postmaster-General Henderson, in charge of the United States Air Mail Service, said that that Service, beginning in 1918, has an efficiency record of 96 per cent. During 4 days of August continuous day-and-night Transcontinental service was maintained, the westbound trips being made in 29 hr. and the eastbound trips in less time. Mr. Henderson said that it is entirely practicable to operate aircraft at night and that within a decade cities more than 500 miles apart may have day-and-night transportation. This will depend largely upon the cost of such service and the income derived therefrom, it not being known what the public would be willing to pay in postage charges for a service of this nature.

Howard E. Coffin was reelected president of the National Aeronautic Association, but resigned the office, which the

Governing Board of the Association filled by electing Frederick Patterson of Dayton.

The Races

Interest centered in the Pulitzer Trophy race, which was won by Ensign A. J. Williams of the Navy, at an average speed of 243.67 m.p.h. over a distance of 124.27 miles. The machine was a Curtiss R2C1, with Curtiss D12 special engine rated at 500 hp.

The Flying Club of St. Louis Trophy race, for two-seaters of 90 hp. or less, civilians only, was won by Walter E. Lees with a Hartsell FC1 airplane at an average speed of 89.31 m.p.h. The distance was 93.21 miles. The machine was equipped with a Curtiss OX5 engine.

The Liberty Engine Builders' Trophy, for observation type two-seaters, military only, was won by Lieut. C. McMullen, in a Fokker CO4 with a 450-hp. Liberty engine, at an average speed of 139.03 m.p.h. over a distance of 186.42 miles.

J. Atkinson won the Aviation Country Club of Detroit Trophy, in a Bellanca CF with an Anzani 95-hp. engine, over a course of 155.34 miles at a speed of 94.80 m.p.h.

The Merchants Exchange of St. Louis Trophy race was won by Lieut. H. L. George in a Martin Bomber with two Liberty 400-hp. engines, over a course of 186.42 miles at a speed of 114.28 m.p.h.

The Detroit News Air Mail Trophy event for Air Mail planes, with Air Mail pilots, over a distance of 186.42 miles, was won by F. F. More with Air Mail Service airplane with a 440-hp. Liberty engine at 124.98 m.p.h.

The Mitchell Trophy race was won by Capt. B. E. Skeel in a Thomas Morse MB3 airplane, with a 300-hp. Wright H3 engine, at a speed of 146.45 m.p.h. The distance was 124.27 miles, the race being open to Army pursuit planes of military type.

The Mulvihill Model Trophy event, for model airplanes not exceeding 40 in. in span, driven by rubber-strand motors, for duration, was won by E. J. Lange of Chicago, with a model that maintained flight for 4 min. 22 3/5 sec.

C. S. Jones won the "On-to-St. Louis" race. He flew a Curtiss-Oriole biplane, carrying one passenger, from Garden City, N. Y. The St. Louis Chamber of Commerce presented the trophy for this event, which was for civilians only, the competitors to fly from any point over 200 miles distant, and the winner determined on the point basis, with credits for speed, distance, passengers carried and horsepower of engine used. Jones' flying time was 13 hr. 30 min.

HELIUM IN AIRSHIPS

THE estimated total output of helium from American sources is 30,000 cu. m. (1,059,433.67 cu. ft.) per day, of which approximately one-third could be collected readily at an initial outlay for the plant of about $70,000,000. Amortizing this capital outlay during the average life of the sources, which is estimated at 20 years, and adding the actual running expenses, the minimum cost of compressed helium amounts to about $2 per cu. m. (7.1 cents per cu. ft.). This cost is based on a probable annual production of 3,000,000 cu. m. (105,943,366.8 cu. ft.) of helium.

The consumption of hydrogen gas in an airship is due (*a*) to osmotic diffusion, (*b*) to the necessary washings for maintaining a predetermined degree of purity and (*c*) to consumption during navigation. In the present state of technique and practical application, the most important of these three causes is the last, which in the case of the regular commercial traffic would assume very high values indeed. If the consumption is calculated for long distance flights and heavy yearly traffic, 4000 hr. of flying per year for example, and it is assumed that the quantity of hydrogen gas that must be lost to overcome the decrease in weight due to fuel consumption is 1 cu. m. per kg. (16.017 cu. ft. per lb.), the yearly consumption of an airship having a volume of 100,000 cu. m. (3,531,445.56 cu. ft.) driven by engines developing approximately 3600 hp. and navigating at half power with an average hourly fuel-consumption of 500 kg. (1,102.31 lb.) is 2,000,000 cu. m. (70,628,911.20 cu. ft.) of hydrogen or 20 times its own value. Practically the entire American output of helium would be required for supplying a single airship on this basis and therefore the cost would be prohibitive. In almost all cases occurring in actual practice it has been found possible to compensate for the fuel consumption during navigation. Consequently the most important of the three causes that make the supply of gas for an airship a serious question is possible of total elimination.

Although it has not been possible as yet to ascertain sufficient data regarding the osmotic loss of helium through the different types of aeronautical fabrics, the experiments carried on at the Institute of Experimental Aeronautics at Rome and also in the United States show that it is not unreasonable to assume a loss of 3 liters per sq. m. (0.00978 cu. ft. per sq. ft.) in 24 hr. Basing our calculations on this figure the airship under consideration, which has a surface of diffusion of 18,000 sq. m. (115,251.1 sq. ft.), would lose through osmosis 19,440 cu. m. (686,513.07 cu. ft.) of gas per year, which is less than 20 per cent of its volume. The relative losses in the case of greater volumes would be even less due in part to the smaller surface-volume ratio.

At present the fresh supplies of hydrogen required on account of consumption during navigation are sufficient to maintain the necessary purity inside the envelope, but where fresh supplies are not available, the washing of the gas becomes a daily necessity, the importance of which is much greater than the actual losses through osmosis. If, for example, it is desired to maintain a purity of 96 per cent with an annual osmotic loss of 20 per cent as calculated above, an annual washing equal to double the volume of the airship is necessary. In the case of helium this cause of great consumption can be totally eliminated by regenerating or repurifying the helium, that is, extracting the air that vitiates it, and by cooling and liquefying the gas.

Of the three causes mentioned that render the replacement of helium necessary, consumption during navigation, washing and osmotic loss, which are in the proportion of 100 to 10 to 1, only the last, which amounts to an annual average of 20 per cent of the volume of supply, cannot be eliminated. This has two important results. First, the necessity of replacement being reduced to this single cause, the available quantity of American helium is sufficient for running not one, but 150 airships of the average volume mentioned above, which is sufficient for a world fleet of civil airships; and second, the cost of helium is within the reach of economical navigation, because apart from the volume of gas necessary for inflation only an annual replacement of 20 per cent of this volume is required. In other words, the initial gas volume necessary for inflating the dirigible is exhausted in a minimum period of 2 years. Considered in this light, helium is no longer a material of consumption but a material of construction of which the required initial outlay for the plant is amortizable in 5 years. Therefore, its substitution for hydrogen in civil enterprise is possible and economically profitable.—Col. A. Crocco in *Aviation*.

Spur-Gear Grinding and Testing

By A. J. Ott[1] *and* C. L. Ott[2]

Production Meeting Paper — *Illustrated with* Photographs and Drawings

A GRINDING machine for finishing spur-gears is illustrated and described; claims are made that it will grind transmission gears on a production basis after they have been heat-treated, will produce correct tooth-contour, smooth finish and accurate tooth-spacing, these features being necessary in producing gears that are interchangeable and that run quietly.

This machine is of the generating type, its action being that of rolling a gear along an imaginary rack and using the grinding wheel as one tooth of the rack. The dished grinding-wheel is reversible, 30-in. in diameter, mounted below the gear, and can be swiveled to the right or left of the center position up to an angle of 25 deg. The work-spindle carries the indexing and the generating mechanisms at the rear, where they are accessible and yet are protected. Two or more machines can be operated simultaneously by one man, as a clocklike mechanism can be set to stop the work-carriage and the grinding wheel when the last tooth of a gear has been ground.

A drum-cam drives the work-carriage. Thin steel tapes are used to accomplish the generating principle; they wind and unwind on a pitch-diameter segment as the work-carriage is driven forward and backward, and produce uniform duplication of tooth-contour. Slight variations of tooth-contour can be made easily by giving a greater or a less angle to the wheel and also by varying the diameter of the pitch-circle or segment.

A machine for testing gears that have been ground is described also; it will develop the involute curve, indicate whether it is true or modified and test tooth-spacing. By means of adapters, engine-front spiral-gears, and bevel-gears, can be checked for accuracy of contour and for tooth-spacing.

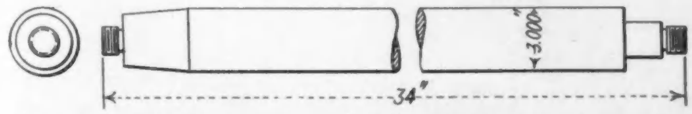


Fig. 1—A Gear-Grinding Machine Spindle That Is Ground Before Being Used

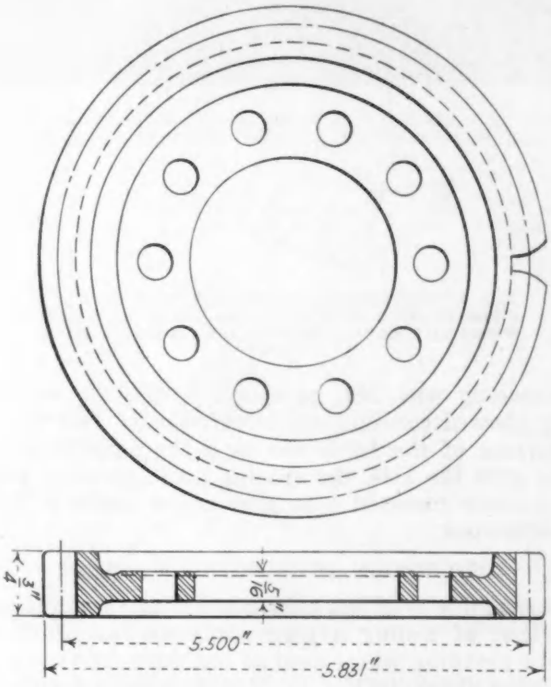


Fig. 2—A Transmission Gear Approximately 6 In. in Diameter That Is Ground on Both Sides Before Oil Hardening

LONG strides forward have been made in the grinding art in the past 20 years; I cite the plain cylindrical field as an instance. It is not so many years ago that the manufacturers of plain grinding-machines urged the economy of grinding; that is, the use of lathes for rough-turning shafts, spindles and the like, and then grinding to the limits desired, so as to insure interchangeability. Automotive engineers and manufacturers grasped and adopted the idea and its advantages quickly. No one would think now of finishing cylindrical parts on a lathe by the old methods; especially would they not think of hardening a part after finishing it to size. For example, in one of our machines, shown in Fig. 1, there is a spindle 3 in. in diameter and 34 in. long; it is of 3½-per cent nickel steel, pack-hardened and oil-quenched. We consider a 0.015-in. warp very little. Of course, the spindle is ground before it can be used.

Fig. 2 shows a transmission gear, approximately 6 in. in diameter, with a ¾-in. face, of 6 pitch and having a 5/16-in. web. This gear is ground on both sides before oil-hardening and, after it comes from having been heat-treated, its sides will show a warp from 0.005 to 0.015 in. The most careful chucking in grinding the hole from the pitch-line will not square-up the tooth bearing-surfaces, for they are no longer parallel. Furthermore, the tooth-spacing of the gear was very good in its green condition, and no interference could be noticed in testing this by hand-rolling; however, after heat-treatment, the

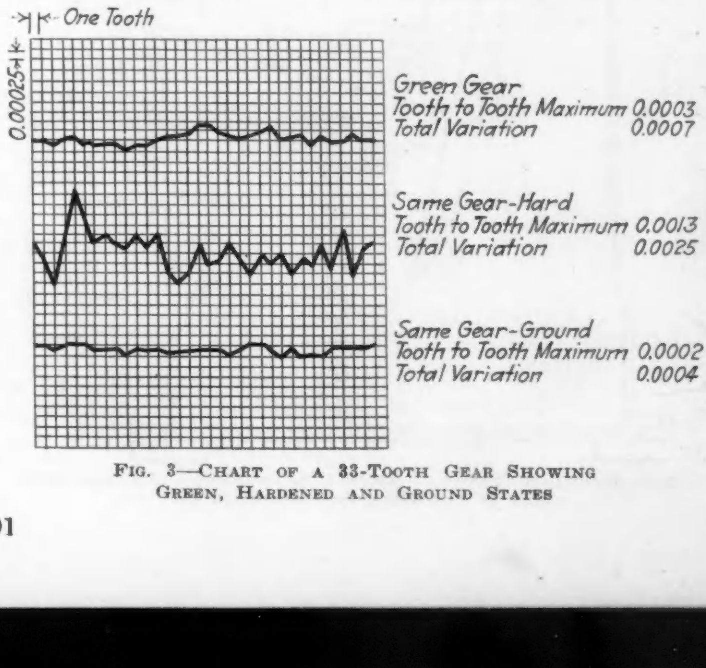


Fig. 3—Chart of a 33-Tooth Gear Showing Green, Hardened and Ground States

[1] President, American Grinder Co., Detroit.
[2] Secretary-Treasurer, American Grinder Co., Detroit.

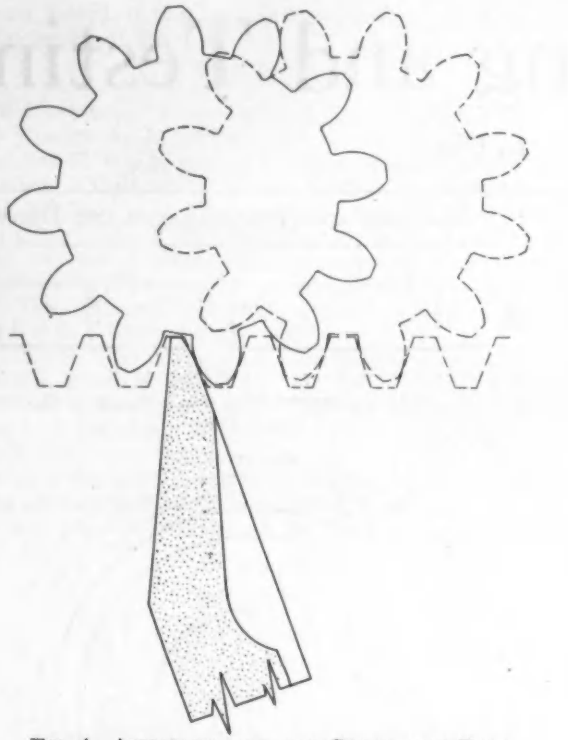


FIG. 4—APPLICATION OF THE GENERATING PRINCIPLE TO GEAR GRINDING, THE GRINDING WHEEL BEING THE EQUIVALENT OF ONE SIDE OF A RACK TOOTH

tooth-spacing was bad, as shown in Fig. 3, and hand-rolling showed considerable interference. But the bearing surface of the teeth can be made parallel and concentric with the hole, the spacing made accurate and the tooth-contour restored with a grinding machine that we have developed.

DESCRIPTION OF GRINDING MACHINE

This machine is of the pure generating type, the action being that of rolling a gear along an imaginary rack with the grinding wheel used as one tooth of the rack, in the manner shown in Fig. 4. Fig. 5 shows a general outline of the machine. The gear is mounted at a suitable loading height; the dished grinding-wheel, 30 in. in diameter, is below the gear and it can be reversed and swiveled either side of the center up to an angle of 25 deg. The work-spindle carries the index and generating mechanism at the rear, where it is protected thoroughly and is very accessible. The carriage is driven by a drum-cam, and a mechanism is provided that stops the carriage, and the wheel also, when desired. All control levers are immediately in front of the machine to the right of the wheel.

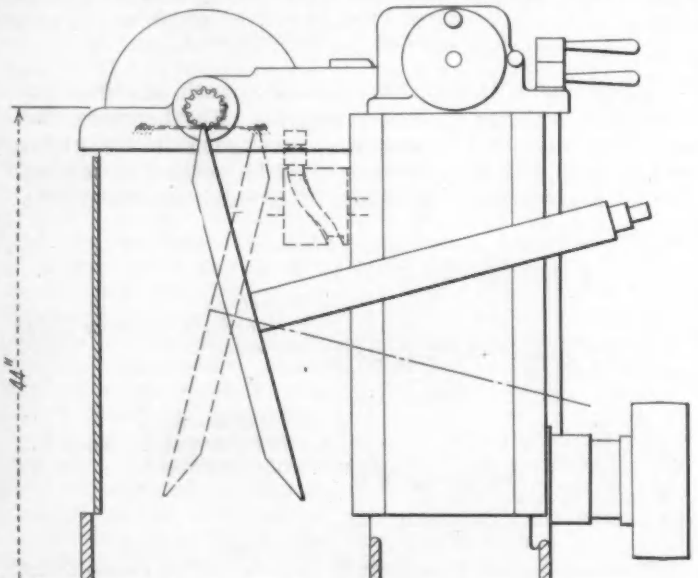


FIG. 5—DRAWING, PARTLY IN SECTION, SHOWING THE GENERAL OUTLINE OF THE GEAR-GRINDING MACHINE

Fig. 6 is a front right-hand side-view of the machine, with the water-guard in place and covering the wheel and the work. The machine is self-contained, has a single-pulley drive, and its general compactness is noticeable. The wheel-spindle is journaled low on the wheel slide-column, and this brings the heavier and high-speed member down nearer the floor. It has a $1\frac{1}{2}$-in. lateral-feed adjustment, and is provided with double end-thrust ball-bearings. The main bearings are made of the best

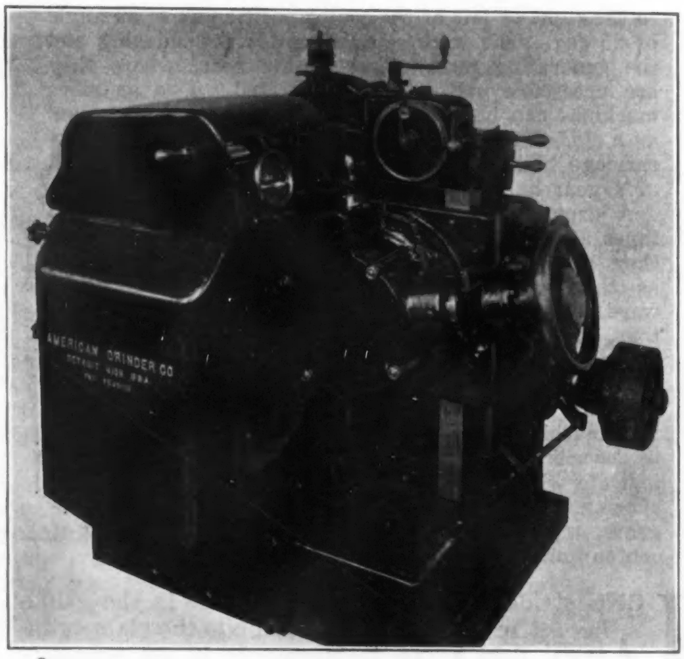


FIG. 6—THREE-QUARTER VIEW OF THE GRINDING MACHINE

bronze obtainable. The amount of feed is controlled by the 12-in. hand-wheel, which is provided with a micrometer adjustment and a positive stop. Fig. 7 shows a sectional sketch of the grinding-wheel and Fig. 8 shows its reversible feature.

The straight edge at right angles to the wheel-spindle does the grinding; it is kept true with a double worm-and-worm-wheel-driven truing-device. While rotating the hand-wheel moderately, the reduction is such that the movement of the diamond is slow, which is necessary to secure a smooth and true grinding surface. Our design of wheel allows a $1\frac{1}{4}$-in. deep surface-wear or truing. An average of one thousand 30-tooth gears of 6 to 8 pitch can be ground on both sides of the teeth with a No. 6636 Combination-J, vitrified wheel, which means two grinds or four passes; this equals grinding 60,000 teeth on one side, twice around, which is the usual grinding method.

The wheel-head is arranged to swivel to the right or to the left of the center, up to an angle of 25 deg. This is particularly advantageous when working on pinion gears, that is, gears with stems; the stem is located in

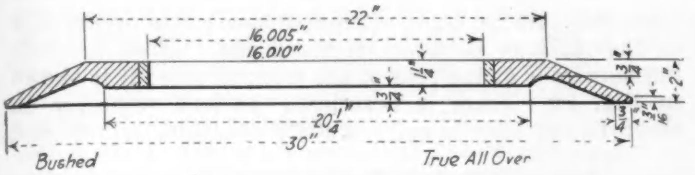


FIG. 7—CROSS-SECTION OF THE GRINDING WHEEL

the holding arbor while grinding either the drive or the coast side of the teeth and, without the swiveling feature, special outboard centers would need to be used, which would be rather inconvenient and not at all practicable in some cases. It is also a very desirable feature when working on some cluster gears; the wheel, of course, is reversed and so is the diamond-holding bracket.

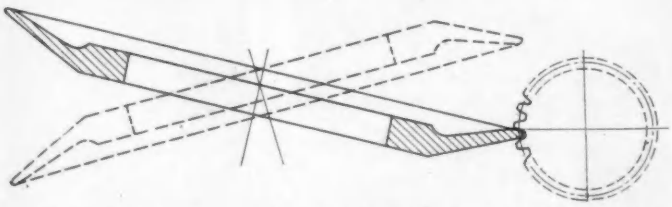


FIG. 8—SKETCH ILLUSTRATING THE REVERSIBLE AND SWIVELING FEATURES OF THE WHEEL

Fig. 9 shows the wheel-head swiveled to the right 20 deg. and grinding an 18-tooth 6-pitch stem-gear on the drive slide. Fig. 10 shows the wheel-head swiveled to the left 14½ deg. and grinding an 18-tooth 6-pitch stem-gear on the coast side.

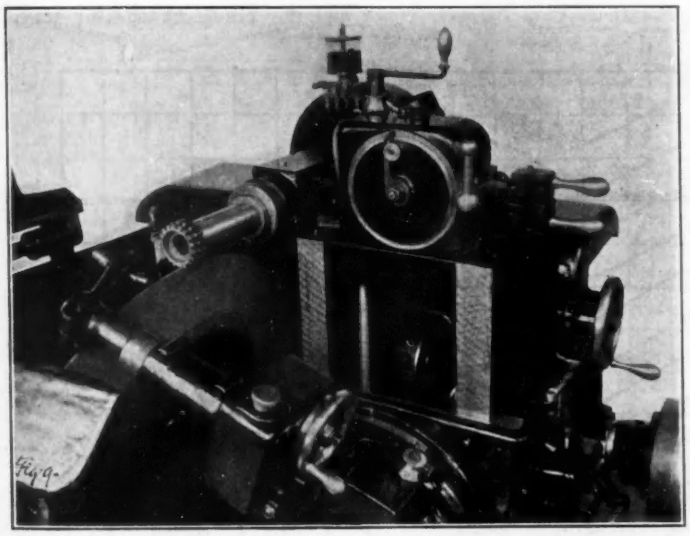


FIG. 9—GRINDING THE DRIVING SIDE OF AN 18-TOOTH STEM GEAR WITH THE WHEEL-HEAD SWIVELED 20 DEG. TO THE RIGHT

The position shown in Fig. 10 is that in which the wheel-head is used most, and on all gears that can be reversed readily. The gear above the wheel is at a suitable loading height and is very accessible. The water-guard is lifted and rocked-up out of the way. A clock-like mechanism automatically stops the work-carriage when the last tooth of a gear has been ground; it also stops the wheel if desired. It is customary to set the stop at twice the number of teeth of the gear that is being ground and to allow the gear to turn around twice; that is, to make what might be called a rough and a finish grind. During the second time around, there is no feed-up to the wheel; it is "sparking-out" as it were. Then, as the last tooth is finished, the carriage stops automatically and so does the wheel, if it is set to stop.

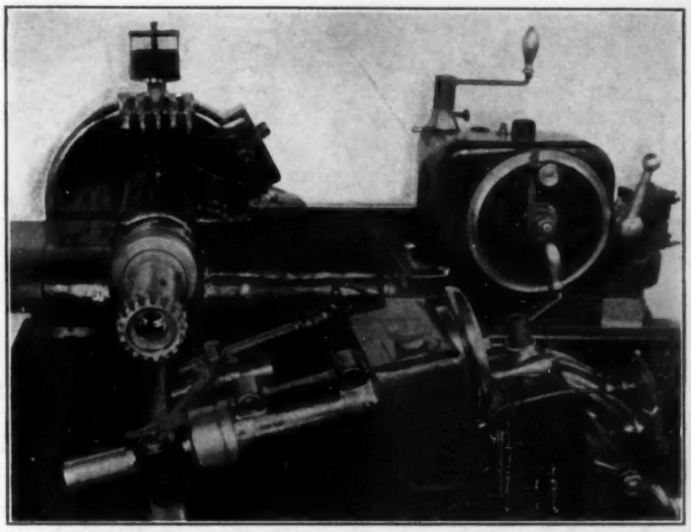


FIG. 10—THE WHEEL-HEAD SWIVELED TO THE LEFT 14½ DEG. FOR GRINDING AN 18-TOOTH STEM GEAR ON THE COAST SIDE

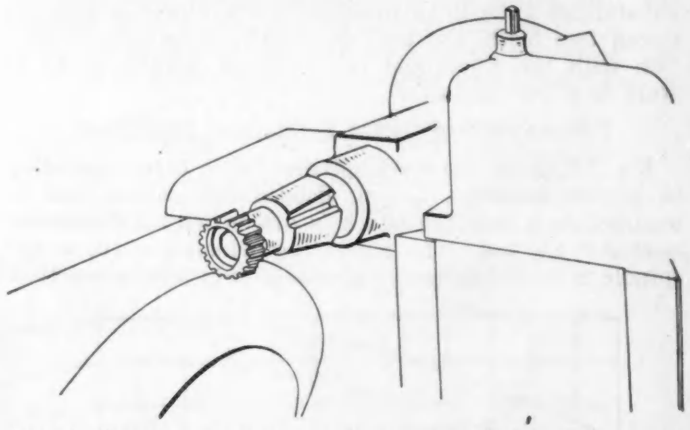


FIG. 11—THE SLOTTED LOCATING RING ON THE ARBOR FOR LOCATING THE GEAR IN THE PROPER RELATION TO THE GRINDING WHEEL

This allows an operator to run two or more machines simultaneously.

The carriage stops with the gear out of the wheel and to its right, so that the arbor can be loaded and unloaded without wheel interference. Of course, the gear must

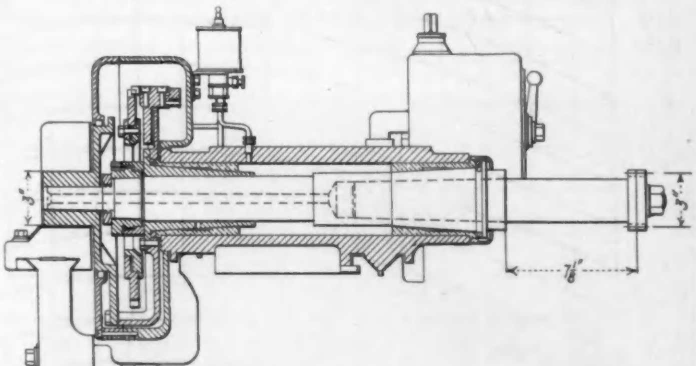


FIG. 12—CROSS-SECTION OF THE WORK SPINDLE, INDEX AND GENERATING MECHANISM

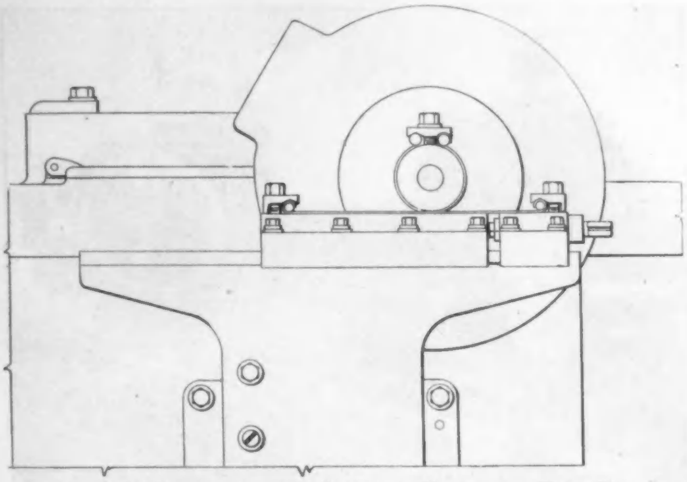


Fig. 13—Sketch of the Segment, Tapes and Tape Bar

be located to mesh correctly with the grinding wheel and, to permit doing this quickly, a slotted locating-ring is attached to the arbor, as shown in Fig. 11. With a substantial knife-gage inserted in the ring-slot and between two teeth, the gear is positioned in proper relation with the wheel and the machine is then ready to start to grind again.

Utilization of the Generating Principle

Fig. 12 shows the work-spindle. It is taper journaled in bronze bearings, having flooded lubrication, and is mounted in a carriage which is driven with a drum-cam located in the bed. The generating principle of the work-spindle is accomplished by means of thin steel-tapes that wind and unwind on a pitch-diameter circle or segment as the carriage is driven forward and backward. This mechanism is at the rear of the work-spindle; it is shown in Fig. 13. There is practically no load whatever on these tapes; they simply oscillate the work-spindle and

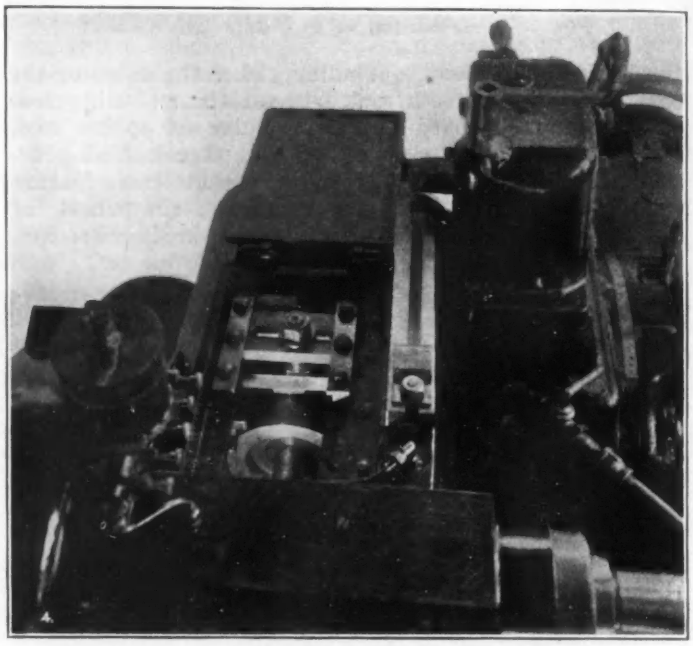


Fig. 14—Looking Down on the Top of the Machine with the Carriage Cover Open

The Drum-Cam Carriage-Drive and the Travel-Adjustment Mechanism Can Be Seen

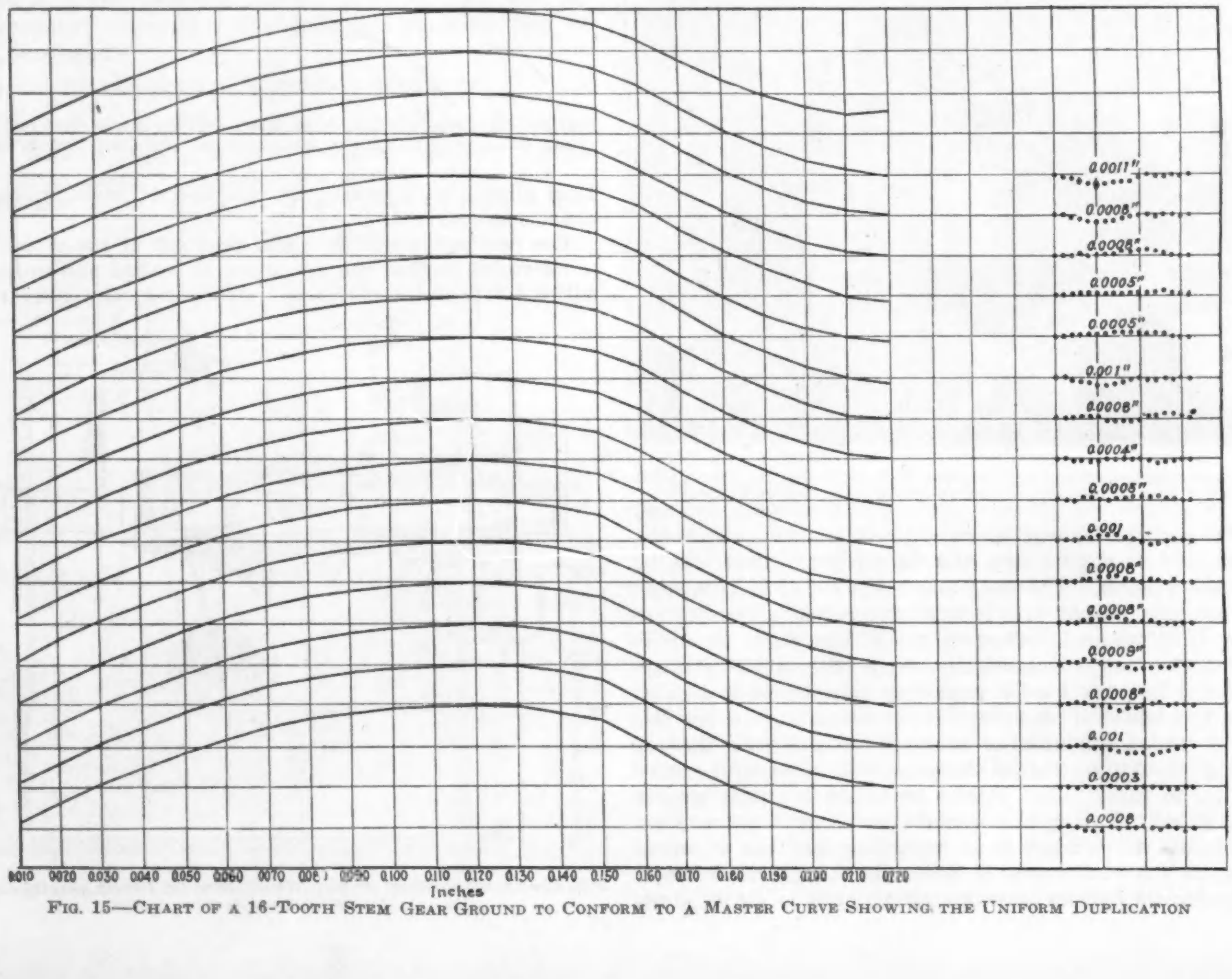


Fig. 15—Chart of a 16-Tooth Stem Gear Ground to Conform to a Master Curve Showing the Uniform Duplication

this enables the carriage to be driven at the same rate of speed on small pinions as on large gears. These tapes are $1\frac{1}{4}$ in. wide and only 0.008 in. thick, using one pair; that is, one end of one tape is attached to the segment and the other end to the tape-bar. The other tape is attached in a reverse manner, and screw adjustment is provided so that the tapes hug the segment snugly and produce uniform duplication of tooth-contour.

Indexing

The index mechanism is very simple; it, also, is at the rear of the work-spindle. Hardened and ground notched plates are used, having the same number of notches as the number of teeth on the gear to be ground. The notches are ground and lapped to very close limits to insure accuracy of tooth-spacing. It requires less than 1 sec. to index from tooth to tooth, and the grinding times vary according to the carriage change-gears used. We usually supply two pairs of change-gears to grind one side of the usual transmission-gear tooth in 5 or 6 sec., according to the accuracy, finish and amount of production desired.

Fig. 14 shows the carriage cover open and illustrates the drum-cam carriage-drive and the travel-adjustment mechanism. The cam-groove provides a smooth and suitable reversing drive, eliminating entirely load-and-fire reverse-mechanisms, clutches and their attendant troubles. The stroke or travel of the carriage is adjustable to suit the pitch of the teeth; also, the position of the carriage in relation to the wheel is adjustable.

Fig. 15 is a chart of 16-tooth 6 to 8-pitch $14\frac{1}{2}$-deg. P. A. stem-gears ground to conform to a master curve, the first curve shown in the illustration. This shows the uniform duplication of tooth-contour that can be ground with our machine at the high rate of 5 sec. per side of tooth. The finish was good and the tooth-spacing was as shown to the right, from readings taken over 4 teeth, or 90 deg. which, besides tooth-spacing, shows-up any eccentricity.

Gear-Testing Machine

Correct tooth-contour of the meshing gears and accurate spacing with a smooth grinding finish produce quiet running transmissions. Slight variations of tooth-contour can be made easily by giving more or less angle to the wheel, and also by varying the diameter of the pitch-circle or segment. We have developed a gear-tester, shown in Fig. 16, in order to measure these minute variations of tooth-contour, to know about the tooth-form and to be able to duplicate established tooth-forms. It consists of a base with a large ground bushing on the left-hand end, to take care of pinion gears, and has holding studs and two slides at right angles.

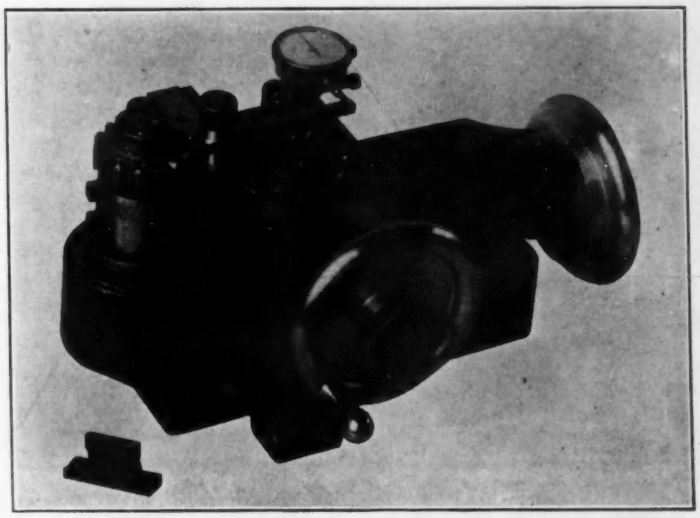


Fig. 16—Gear-Testing Device That Has Been Developed To Check the Involute Curve

Two methods can be used with this gear-tester. In starting to grind gears, good-rolling green-gears can be picked out from production and tooth-curves can be charted by using the lower slide of this tester and then adjusting the grinder to duplicate these curves. The other method is to make base-circle adapter-studs, and

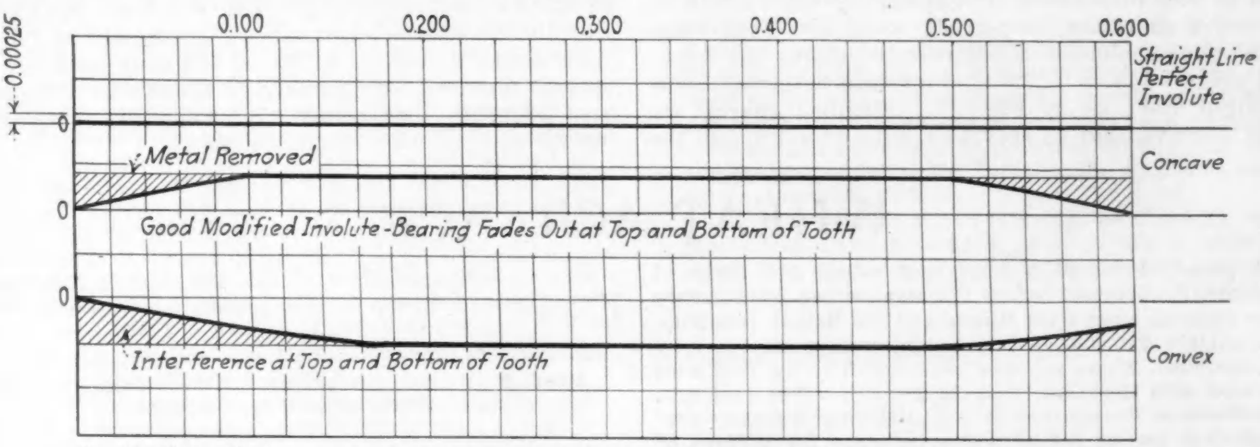


Fig. 17—Chart Plotted by the Gear-Testing Device Showing the True Involute and Modified Curves

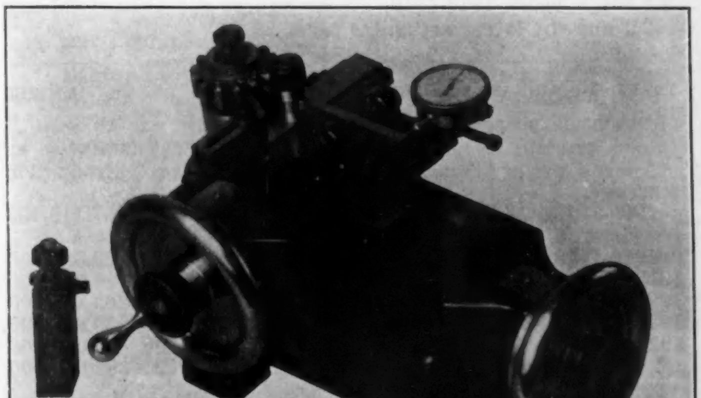


Fig. 18—Gear-Testing Device Arranged for Checking Tooth Spacing

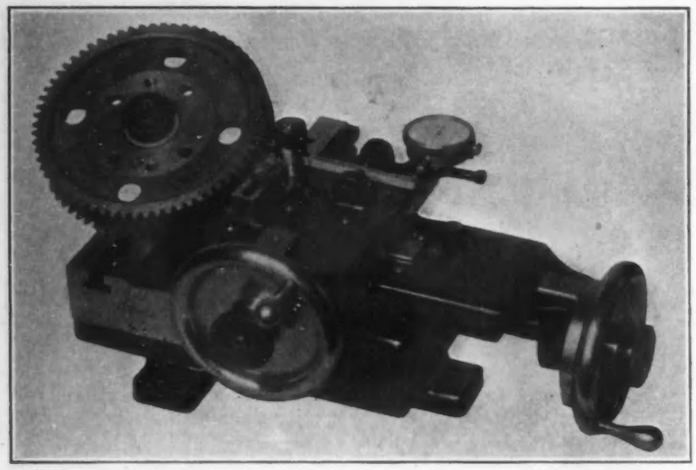


FIG. 19 — THE GEAR-TESTING DEVICE EQUIPPED WITH SPECIAL ADAPTER FOR CHECKING THE TOOTH CONTOUR AND SPACING OF HELICAL GEARS

these will give the variation of tooth-contour from the true involute. Two steel tapes are attached to the stud and the top slide; this insures correct indication without slippage on the smallest gears. If the tooth being tested is a true involute, the indicator will remain at zero and a chart can be plotted, using the hand-wheel graduations; a plunger automatically retards the hand-wheel every 0.010 in. The true involute tooth will show a straight line, as in Fig. 17. Modified curves are usually concave, that is, they fade out at the top and the bottom as shown in Fig. 17; if convex, there will be interference, as shown in the illustration.

Tooth-spacing can be tested either by direct reading, or with the post set at an angle of 90 deg. as shown in Fig. 18. The indicator needle can be reversed in cases where it is not possible to reverse the gear. By making special adapters, as shown in Fig. 19, engine-front spiral-gears, and also bevel-gears, can be checked for tooth-contour and tooth-spacing.

SUMMARY

By using the machine and methods described, fine finishing cuts, burnishing and polishing operations can all be eliminated. Real economical production of transmission gears is attained by roughing-out the teeth to about a 0.005-in. oversize tooth-thickness, depending on the amount of backlash desired; then harden the gear, grind the hole or stem, and afterward grind the teeth. Why spend so much time with finishing operations and then subject the gears to heat-treatment? Even with the greatest of care, there is then some distortion. The finishing can be done best by grinding after hardening, and it can be done in about the same or even less time.

Just as all now agree with the plain cylindrical-grinder representatives, so now the teeth of transmission gears can be ground to established tooth-forms and limits and assembled interchangeably. The gears run quietly and stay in the transmission cases. There will be no more "tear-downs"; that is, so far as the gear teeth are concerned, provided, of course, the proper tooth-form has been adopted. Our system of developing, grinding and testing accomplishes this effectively.

WHEAT ACREAGE

THE principal countries importing wheat are those of Western Europe and before the war an important share of their supplies came from Russia and the Balkan countries. Approximately 200,000,000 bu. annually were exported by these countries. These supplies were cut off in the first year of the war, with the result that the price of wheat rose rapidly in Western Europe and in all producing countries free to reach that market. Under this influence the acreage of wheat was enlarged, not only in the United States, but in other countries, and particularly in Canada, where a great opportunity for expansion existed in the Prairie Provinces.

The increased acreage and production of wheat in the United States and Canada under the stimulus of the war prices are shown by Table 1, which gives the average of each country in the 5 years preceding the war, the average for the 5 years 1914-1918, actual figures for 1919, 1920 and 1921, and the latest estimates for 1923.

TABLE 1—WHEAT ACREAGE AND PRODUCTION OF THE UNITED STATES AND CANADA

	United States		Canada	
	Acreage	Production	Acreage	Production
Average, 1909-1913	47,097,000	686,694,000	9,945,000	197,119,000
Average, 1914-1918	54,119,000	823,446,000	13,783,000	229,839,000
1919	75,694,000	967,979,000	19,125,000	193,260,000
1920	61,143,000	833,027,000	18,232,000	263,189,000
1921	63,696,000	794,893,000	23,261,000	300,858,000
1922	61,230,000	856,211,000	22,631,000	400,000,000
1923[a]	....	793,083,000	....	383,000,000

[a] Latest official estimates.

It will be seen that the increase in Canadian production alone approximately equals the entire annual exports from Russia and the Balkan countries before the war.

The average production of the five leading export countries outside of Russia for the 5 years ended with 1913 and for 1922 is given in Table 2.

TABLE 2—WHEAT PRODUCTION IN THE LEADING COUNTRIES EXCLUSIVE OF RUSSIA

	Average, 1909-1913	1922
Argentina	157,347,000	215,320,000
Australia	84,943,000	105,000,000
Canada	197,119,000	400,000,000
India	349,919,000	366,352,000
United States	690,109,000	856,211,000
Totals	1,479,437,000	1,942,883,000
Increase	....	463,446,000

This shows an increase in these countries of more than double the former exports of Russia and the Balkan countries. The average acreage in wheat in these five countries for the period of 1909-1913 was 108,682,000 acres; for the peak of the war period it was 141,626,000 acres; and for 1923 it was 136,795,000 acres.

It appears therefore that there is no mystery about the low price of wheat this year, especially when it is considered that the buying power of the importing countries has been below par, forcing them to resort to cheaper foods than wheat. Moreover, the situation as to wheat has been advertised as rather worse than the facts warranted. The carry-over in this Country has been exaggerated. The July reports of the Canadian crop represented one of 500,000,000 bu., and reports have been current that Russia might make indefinitely large exports. Under all this it is not strange that support for the market has been lacking. There has been no profit in carrying grain from harvest time to the end of the crop year in any year since 1920.—George E. Roberts in *Journal of American Bankers Association.*

Research Topics and Suggestions

THE Research Department plans to present under this heading each month a topic that is pertinent to the general field of automotive research, and is either of special interest to some group of the Society membership or related to some particularly urgent problem of the industry. Since the object of the department is to act as a clearing-house for research information, we shall be pleased to receive the comments of members regarding the topics so presented, and their suggestions as to what might be of interest in this connection.

FINISHING PISTON-RING GROOVES

A NUMBER of members have written the Research Department requesting information on the various practical methods of finishing piston-ring grooves to a very high degree of polish and accuracy. Attention is called to the fact that finishing with the ordinary forming-tool leaves a series of tool-marks or ridges that wear away initially very rapidly, thus creating an objectionable leakage space around the rings. Processes of grinding and lapping, which have been suggested, possess obvious disadvantages when considered from the point of view of production.

In an effort to obtain useful information on the subject, the Research Department communicated with leading manufacturers, a number of whom have outlined their methods for the benefit of others who may be interested.

The following extract is from a letter from a manufacturer who finds it possible to finish the grooves satisfactorily with suitable cutting tools:

> In our regular production we use the customary method of machining the grooves in the pistons, but to hold the grooves to size and get as smooth a finish as possible on the sides, we make a roughing and a finishing tool. By properly shaping the tool on the finishing cut we are able to secure a fairly smooth surface on the sides of the grooves. We also take considerable pains to keep the piston from moving endwise ever so slightly during this operation, as this produces wavy grooves and permits loss of power and leakage of oil.
>
> Some time ago we installed in an engine two pistons with the grooves very accurately tooled and polished. The remaining two pistons were of our standard production. We ran several tests to determine the ability of the two types of piston to hold compression, but were unable to ascertain whether the pistons with the polished grooves were superior to the others in this respect.

The forming tool is also found satisfactory by another automobile builder who writes:

> We find that an ordinary forming tool, when properly ground, is very satisfactory for this purpose. Some of the essential details are proper hardness of the tool, proper setting, point clearance, feed and speed and the condition of the piston iron. When these conditions are met a smooth and true groove should be the result.

No commercially satisfactory method of grinding piston-ring grooves seems to have been perfected. The experts of one of the foremost grinding companies brought out the fact that, even though it were possible with properly shaped wheels and present methods to grind the grooves very satisfactorily, yet it would be a toolroom job, not susceptible of easy adaptation to a production basis.

Perhaps the most promising methods offered for finishing grooves involve burnishing or rolling operations. One prominent company writes:

> The groove is first roughed out with a solid tool to approximately full depth and ⅛ in. wide. Then on another machine a second cut is taken which deepens the groove slightly and widens it to 5/32 in. This we hold to a tolerance of 0.01 in.
>
> On the same machine and with the back cross-slide the third cut is taken with split tools that do not cut at the bottom of the groove at all but simply shave the sides to a limit of from 0.1868 to 0.1878 in.; at least these are our gage limits but the piston grooves are actually made much closer than this.
>
> The fourth operation on the grooves is on a lathe where we run in a revolving burnishing disc that has sharp edges and is 0.1873 in. wide. This burnishes the sides of the groove and removes any ridges that might be left by the finishing tool.
>
> The final operation on the grooves consists of burring the corners and polishing the bottom with a narrow strip of emery cloth.
>
> In our opinion this method is as good as any unless we wish to go to a very expensive lapping operation. I believe also that the chief cause of wear between the ring and the groove is the roughness of the ring itself on the side. These rings are very hard and they are usually rather rough on the side from improper grinding and there is a filing action between the ring and the groove due to the fact that the ring is so much harder than the piston.
>
> It is now possible to lap the rings on the sides very economically and accurately, and we are considering doing this, as we will secure a flat, smooth, accurate ring that would certainly contribute greatly to longer wear.

A second company writes:

> The method followed in our factory for finishing piston-ring grooves is to burnish with hardened, ground and lapped high-speed steel rollers running in oil, set on a shaft in a holding fixture and used in a lathe. The rollers have a lateral movement to compensate for variation between grooves. The width of the rollers is about 0.0003 in. greater than the maximum width of the groove gage. The proper width of the rollers is controlled by the grade of cast iron in the pistons. The operation is short and is very satisfactory.

A third company states:

> So far our best results have been obtained from a burnishing roll or disc of approximately the same diameter as the piston, mounted on ball bearings and attached to the cross-slide of a lathe, burnishing one groove at a time. We are now equipping to try a combined skiving and burnishing operation.

Another factory uses a tool-holder carrying a series of hardened steel discs of the correct thickness, properly spaced to fit the piston-ring grooves. These discs burnish the metal on each side of the groove and have apparently proved successful.

Furthermore a motorcycle manufacturer reports as follows:

> We have done a great amount of experimenting in this direction, using a finishing roll about 5 in. in diameter made of carbon steel, ground and lapped to the proper width, and ground to produce very sharp corners. We found the roller would not work with

round corners. This roll was mounted on a stiff bearing, permitting the roll to float sidewise so that it could line up with the groove. The piston, made of cast iron, was held in fixture in a screw machine with the roller on the cross-slide. From 0.0005 to 0.0020 in. was left in the width of the groove for the roller to reduce to size. The roller was fed into the groove to the proper depth and with 0.0005-in. oversize stock the roll action was a smoothing operation and with the 0.0020-in. oversize stock a cutaway one, but in either case the finish produced was a very smooth, compact surface on both sides of groove. We found that straight carbon tool-steel rolls wore away and lost their size rather fast, and we changed over to S. A. E. 3120 chrome nickel steel, carbonized and hardened, which we found will outwear tool steel in an operation of this kind. We believe that good results may also be obtained by using regular chrome ball-steel.

A plant that has not found success with the above methods writes:

> We have done some experimental work in an attempt to improve our present method of finishing these grooves, principally with highly polished rolling-tools, and thus far have not been successful in improving at all on the method that we have always used. This method consists of making two cuts in the ring grooves. the first cut roughing them very close to size and the second cut taking a very fine finishing cut with a reasonably slow feed.

It is hoped that further material will be received from any of our readers who may care to offer it.

Important Sections Matters

Action Taken at Meeting of Council in Cleveland Relating to Non-Member Affiliation with Sections and Change in Dues

AT the meeting of the Council held in Cleveland, Oct. 24, several important decisions were reached with regard to Sections matters. A definite plan for the collection of dues of the Sections by the office of the Society, beginning with the next fiscal year, will be formulated for consideration at the meeting of the Council this month. A special committee was appointed to study thoroughly the relations of the local units of the Society to the parent organization, with the purpose of bringing about such reorganization and modernization as may be considered necessary or advisable. It is expected that this committee, in the work of which the Sections Committee will join, will hold hearings for a general discussion of the issues defined as to the basic principles in the providing of adequate local as well as national activities. The officers of all of the Sections will be fully informed as to the work being done by the committee from time to time.

Among the things to be studied is the reestablishment of a form of affiliation of non-members of the Society with the Sections, similar in principle to the enrollment of Section associates that was in effect several years ago but discontinued by Council direction. As stated elsewhere in this issue of THE JOURNAL, a demand has arisen in several Sections for such action, and the Sections Committee has been requested to draft an enabling provision for consideration in amending the standard Sections Constitution and By-Laws.

The subject of abolishing Sections dues as such and raising the amount of the annual dues of the Society to provide proper financial support for the maintenance of Sections activities to the extent of all reasonable demands is also before the committee.

OCTOBER COUNCIL MEETING

THE meeting of the Council held on Oct. 24 at Cleveland was attended by President Alden, Past-President Bachman, First Vice-President Crane, Second Vice-President Scarratt, Councilors Chryst, Gurney, Scaife, Scott and Swetland. J. H. Hunt, H. L. Pope and M. P. Rumney, nominees for the 1924 Council, were also present.

The books of account for the fiscal year ended Sept. 30, 1923, are being audited by public accountants and it is expected that the unexpended income for the year will be over $15,000. A budget for the current fiscal year was approved on the basis of an expected income of $275,000.

Applications for membership in the Society to the number of 87 were approved.

The following appointments to the Standards Committee were made:

R. E. Carlson—Lighting Division
Norman Conn—Iron and Steel Division
W. W. Davison—Axle and Wheels Division
W. J. Outcalt—Screw Threads Division
H. W. Sweet—Transmission Division

The next meeting of the Council will be held at Dayton on Nov. 20.

THE FARMER

TODAY the farmer's financial isolation is a thing of the past; special credit legislation has brought that about. Today the farmer's physical isolation is capable of very material modification; the telephone, the automobile, the radio have accomplished that. Today the farmer's political isolation is on the way to annihilation; the farmer's own aggressive action has achieved that. What we still need to accomplish is the wiping out of the farmer's social and mental isolation.

This last is not a problem peculiar to the farmer. It is something we must face and must answer in the case of every unit of our population. We must reduce, if not eliminate entirely, the isolation of ideas or ideals on the part of foreign-born, on the part of labor, on the part of farmers—yes, on the part of bankers. We must guard ourselves against the danger of isolation, of selfish consideration of our own interests exclusively or even primarily. We must all learn to function as partners in a common enterprise—the progressive development of our Country as an increasingly better place in which to live.—W. W. Head, Omaha National Bank.

The Standardization of Methods of Applying the Scleroscope

By A. F. Shore[1]

Production Meeting Paper *Illustrated with* Photographs and Charts

A STATEMENT is made of nine items suggested by the Iron and Steel Division of the Society for consideration with reference to securing greater uniformity in practice when making precision hardness-tests with the scleroscope. Plumbness of the instrument is an important factor and lateral vibrations have a bad effect; these are discussed and surface smoothness of the test-specimen is considered in relation to its effect on accuracy.

Other factors treated are the influence of metal-scale on scleroscope readings, the condition of the hammer diamond, and the effect of the mass of the test-specimen. Extreme under-weight specimens, inert and over-weight masses, the effect of hardness on mass and the effect of thickness of the test-specimen receive consideration, together with points concerning testing near test-specimen edges, the effect of curved surfaces and how test-specimens are held. A lengthy comparison between Brinell and scleroscope hardness-testing is made. The paper presents photographs and illustrative charts.

THE scleroscope has now been adopted so generally and is used under such varied conditions that a need has come to be felt for the greatest possible standardization of methods for its application. In addition to their regular instruction literature for this instrument, which is designed for the most universal application, its manufacturers have always maintained a

[1] M.S.A.E.—President, Shore Instrument & Mfg. Co., Jamaica, N. Y.

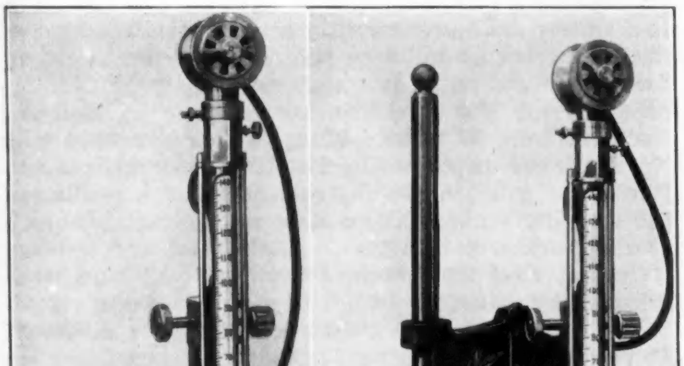


Fig. 1—Two Views of the Vertical Scale Scleroscope

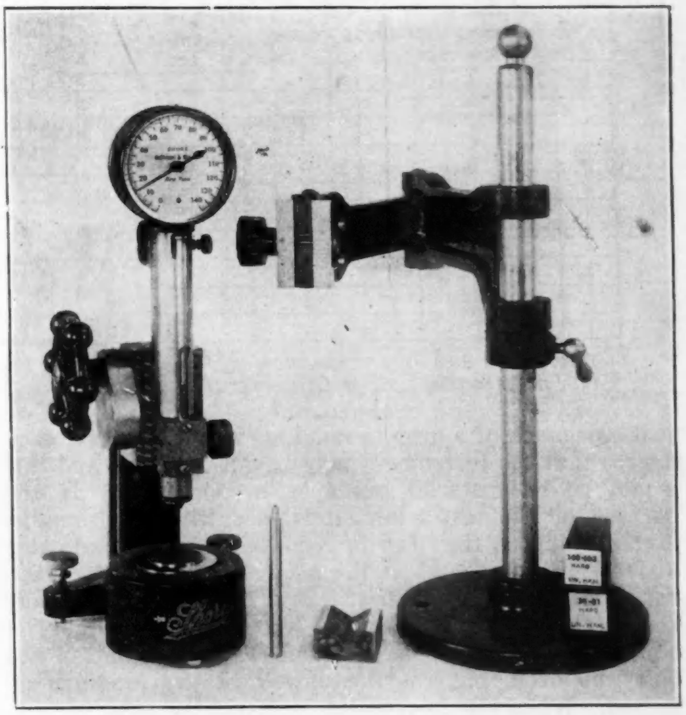


Fig. 2—The Recording Scleroscope

department devoted to the study of special problems that have arisen relative to precision hardness-testing, particularly in quantity-production operations. However, they recognize the importance of securing more complete data relative to a better systematization of practice so that concordant results can be obtained more easily, independently, by everyone and under all conditions. To this end, the members of the Iron and Steel Division of the Society suggest the following items for consideration and treatment:

(1) Plumbness of the instrument at the time of hammer-drop
(2) Effect of lateral vibrations or shocks on the hammer
(3) Smoothness of surface of the test-specimen
(4) Condition of the diamond in the hammer
(5) Effect of mass on the test-specimen
(6) Thickness of the test-specimen
(7) Effect of testing near the edge of the test-specimen
(8) Effect of curved surfaces of test-specimens
(9) How test-specimens are held or mounted

Plumbness of the Instrument

Manufacturers' instructions to users always have been to set or hold the scleroscope as perfectly plumb as possible. The deviation should remain within 1 deg. The instrument will then indicate with 100 per cent accuracy. Notwithstanding this advice, it is of importance to know

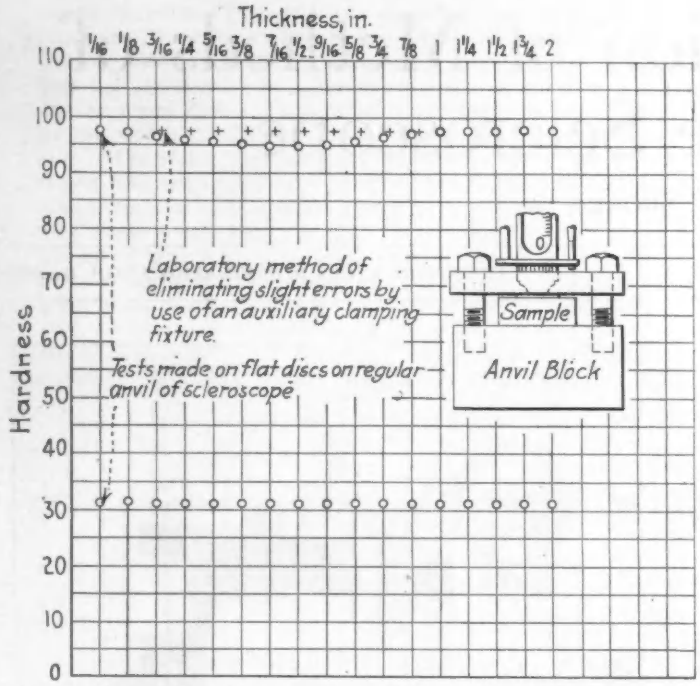


Fig. 3—Results of Hardness Tests Made on Discs Measuring 1 5/8 In. in Diameter and of Different Thicknesses

just how much of a drop in readings would occur for each degree that the instrument may be out-of-plumb and this would be of material guidance to operators. If the surface of the test-specimen is also tilted or remains at right angles, the drop in readings thus approximates about 0.007 per cent on the scleroscope scale for each degree of angle for the first 5 deg. At 10 deg. of angle, the total drop in readings is about 8 per cent. The objection to holding the instrument out-of-plumb is not only the drop, but the fluctuation in the readings so caused. When the instrument is permitted to be out-of-plumb, but the surface of the test-specimen is level, the errors on both hard and soft metal are proportionately

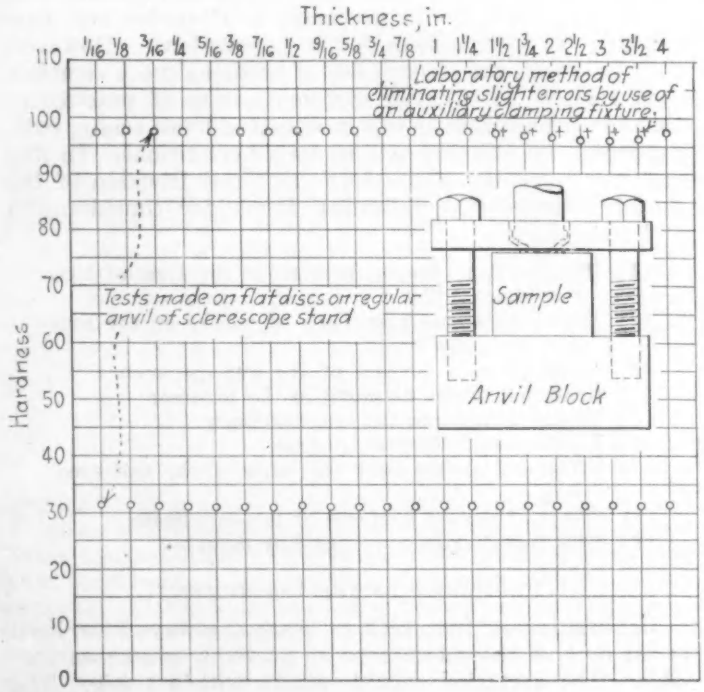


Fig. 4—Results of Another Series of Hardness Tests Made with the Recording Scleroscope on Discs of Different Thicknesses

greater because of the glancing blow struck. Table 1 shows the errors for deviations of 1 to 5 deg., and for 10 deg.

TABLE 1—SCLEROSCOPE ERRORS FOR VERTICAL DEVIATION

Deviation from Vertical, Deg.	Loss, Per Cent
1	1.0
2	2.5
3	4.5
4	7.0
5	10.0
10	33.0

A deviation from the vertical of as much as 2 deg. is easily noticeable to the unaided eye; 3 deg. is decidedly noticeable. Both the Model-C vertical-scale scleroscope shown in Fig. 1 and the Model-D recording scleroscope shown in Fig. 2 are affected equally under the conditions just cited.

Effect of Lateral Vibrations

It is understood that, in the test made for deviations from plumbness, both types of instrument were held steady or free from lateral movement or shocks. When either type of scleroscope is moved or shaken roughly enough to rattle the plumb-rod, it has a marked effect upon the accuracy and uniformity of the instrument's indications, because of the effect on the drop-hammer. These conditions must be observed when free-hand tests are made.

Surface Smoothness of the Test-Specimen

Having the surface of the test-specimen too rough causes a drop in the readings, but not so much as usually is supposed. The principal objection to rough surfaces in scleroscope practice is the fluctuations thus caused in the readings. These are more misleading than the percentage of drop in the readings.

If a test-specimen of flat hardened-steel about 1½ in. wide shows a reading on the scale of 100 hard on a comparatively smooth surface, and this surface is then ground on the side of a rough but true emery-wheel 14 in. in diameter and tested again, the reading will fall to and fluctuate from 94 to 98 on the scale. If the same surface is ground on a disc machine faced with No. 2½ paper having No. 60 emery, the readings will fall and fluctuate from 97 to 99. When further smoothed with No. 20 French paper having No. 120 emery and the surface is not polished, the instrument shows a reading of 100 very uniformly. No increase in readings is obtainable by further polishing.

On soft steel that shows a reading of 32 hard when polished, by using the same coarse-emery stone, a reading of only 29 to 31 is obtained, and this is a drop of 9.3 per cent and 3.1 per cent in the readings. Using the same No. 2½ paper having No. 60 emery, a reading of 29 to 32 is obtained. The effect of using smoother papers, until practically a mirror finish is obtained, is not to increase the reading, namely, 32, but to reduce the variations to zero.

On metal that can be filed, the maximum readings are obtained by the use of a flat crossed-cut file having about 70 teeth per in. If the teeth are not crossed-cut, a file having about 50 teeth per in. will make the surface smooth enough.

Influence of Scale on Metals

Experience has demonstrated that the scale on steels in the soft condition influences the scleroscope readings

only slightly. Therefore, it is feasible to select the high-carbon steels from the low-carbon steels taken from a pile of mixed bars, the identity of which has been lost. The condition necessary for making determinations under these circumstances is that the test be made where the scale is as smooth as possible, or free from blisters or rust. When the steel is hardened, it also can be tested through the scale by making allowance for a small loss or drop in the readings. Here, too, it is important that the scale be dry and also free from rust. Two or three tests should be made because of the unfavorable surface conditions, and the results should be averaged.

The Condition of the Hammer Diamond

The condition of the diamond in the scleroscope drop-hammer of both the Model-C vertical-scale and the Model-D dial-recorder instruments is determined regularly by making a few tests on standard reference blocks which accompany each testing unit. If they check-up properly, the diamond is considered to be perfect. If it reads low, particularly on the hard reference-block, it is because the point either has become roughened or has worn more pointed. These diamonds are not polished, but they are reasonably smooth and observation through a magnifying glass will disclose whether or not their failure to check properly with the standard blocks is due to the condition of the diamond or to some other cause.

In this connection, many are calling for special checking-blocks having a hardness that compares as nearly as possible with that of a particular run of parts which are made in quantity. This will serve to reduce uncertainties in inter-practices to a minimum.

Effect of Mass of the Test-Specimen

Some users still suppose that, in measuring hardness with the scleroscope, the accuracy of the results on small test-specimens depends directly upon the mass of the test-specimens and that, as this mass is increased, the readings also become higher. To a certain extent, this would be true if the specimens of metal to be tested were suspended in the air or mounted on an anvil or base of some light yielding substance such as wood or rubber. However, since it is just as easy to use the steel anvil with which all scleroscopes are provided, all the following tests to be discussed will be considered to have been made on a steel anvil inserted in an iron base heavy enough to resist the shocks of the drop-hammer, or the equivalent, the anvil on all special holding devices. When the test-specimens are supported properly in this manner, it is found that variations in their mass amount to so little that accurate measurements can be obtained easily and uniformly. In the technique of mounting or clamping, particularly for complex specimens, it is none the less important to understand the several basic interfering factors that may enter.

This subject already has been treated in Chapter 12 of an instruction booklet entitled The Effect of Mass on Rebound, that accompanies each scleroscope testing-set; therefore, it is thought that the main interest at this time centers in charts that show curves of the results. The data were obtained on under-weight specimens of varied sizes and shapes used in actual practice; in the laboratory for absolute accuracy, and in the shop under production methods such that the principal object sought is uniformity and speed, but which readings may depart slightly from the laboratory results and for which the indicated allowances would then need to be made.

Results thus obtained from testing small flat specimens

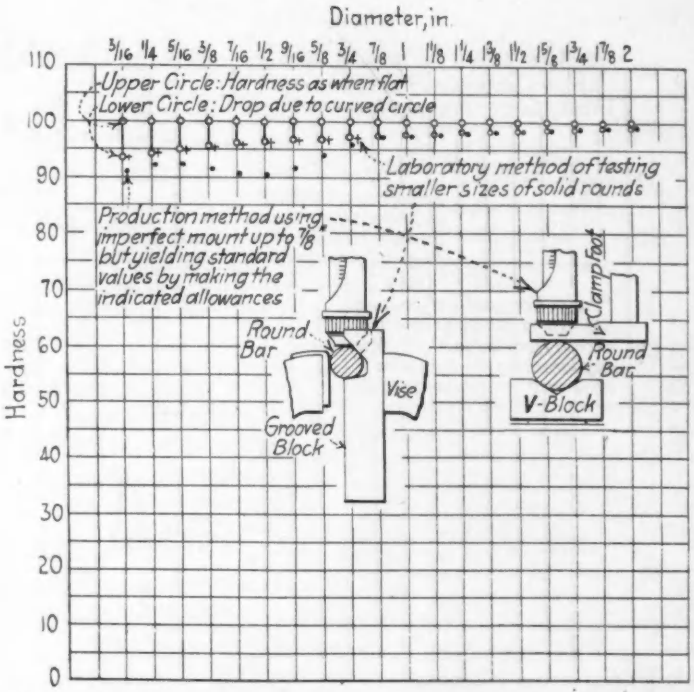


Fig. 5—Results of Hardness Tests Made with the Vertical Scale Scleroscope on Hardened Cylindrical Pieces of Different Diameters

that are not especially prepared with reference to flatness and smoothness but, rather, which have commercially ground surfaces and are clamped in the portable stand of the Model-C scleroscope, are shown in the curve of open dots in Fig. 3, and for the Model-D recording scleroscope in Fig. 4. The corrections on hardened samples by having the specimens ground smoother so as to lie perfectly flat and thus eliminate air space and dust, when clamped in the regular stand, are shown in the curve that is constituted of small crosses. This latter curve also applies to the special clamping-down fixtures in Figs. 3 and 4, and when using the scleroscope on its clamping

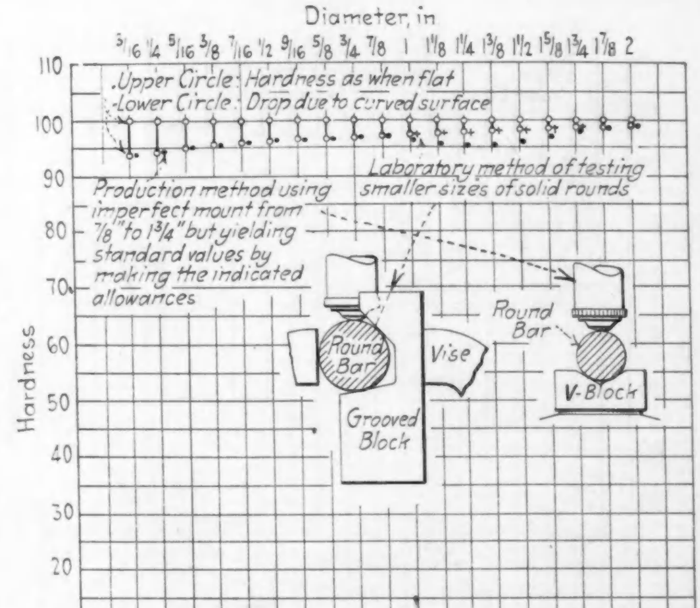


Fig. 6—Results of Another Series of Hardness Tests Made with the Recording Scleroscope on Hardened Cylindrical Pieces of Different Diameters

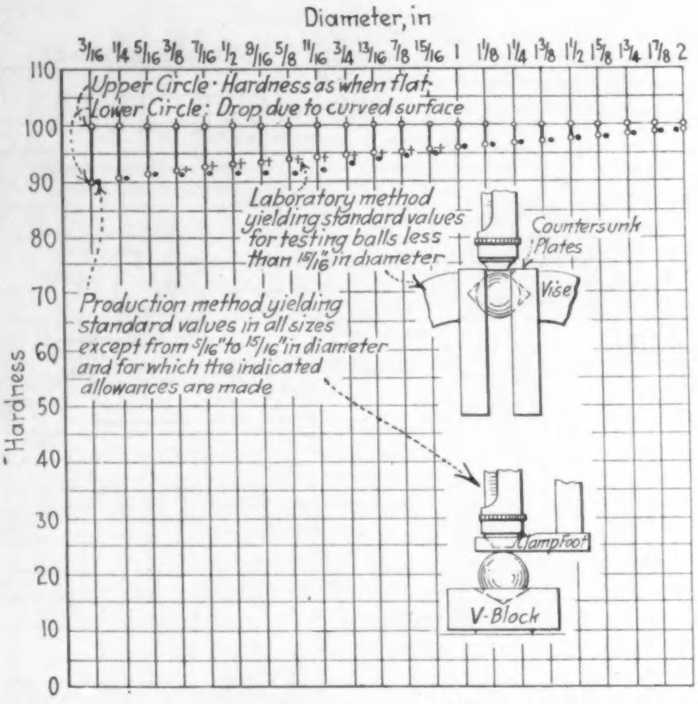


FIG. 7—RESULTS OF TESTS OF HARDENED STEEL BALLS OF DIFFERENT DIAMETERS MADE WITH THE VERTICAL SCALE SCLEROSCOPE

stand or when resting on a bench plate with the instrument on its swing-arm.

For small round specimens, the test results obtained are shown in Fig. 5 for the Model-C scleroscope and in Fig. 6 for the Model-D recording scleroscope. It will be seen that by merely using a V-block without making special provisions for obtaining precise laboratory results, the size is an interfering factor; (*a*) because of lack of proper under-support and (*b*) due to the lack of mass. The results obtained when using the V-block method of support, which is used for production purposes, are shown in the solid dot curves. The correct values, as obtained by clamping the specimen in a grooved block in the bench vise, are shown in curves of small crosses. In the curve that is made up of the small circles the still further corrected values obtained by making allowances for the curvature of the test surface are shown.

Figs. 7 and 8 show the results obtained on hardened steel balls for the Model-C and Model-D instruments respectively. Here also, the solid dot curves stand for values obtained in a circular V-block in the clamping stand. As a support, it is only approximately correct, but it serves the purpose well for rapid production purposes, particularly in centralizing the ball. For precise values, a recessed pair of blocks having a hardness of about 70 was used for clamping the balls in a bench vise, shown in the insert. The curve of small crosses shows the resulting values; and the curve of the small circles shows the increase due to stoning the series of balls flat, or the allowances regularly to be made for the curvature of test surfaces.

Figs. 9 and 10 show tabulated test results that were obtained on case-hardened and soft hollow piston-pins, for Model-C and Model-D instruments respectively. The curves of the solid dots show values obtained on hollow piston-pins in both the soft and the hardened condition when supported in a V-block, and without using a plug on the inside. The thickness of the wall of the series of sizes given was one-sixth of the diameter of the pin. Other pins were tried that had a thickness of wall of one-eighth and of one-tenth the diameter of the pin without departing materially from this curve. A more correct curve indicated by small oblique crosses is shown also; it was obtained by clamping the unplugged hollow pin in a bench vise provided with a well fitting split-block. A still better method is to plug the hollow pin and to test either on the V-block or in the split-block in the bench vise, and this will give absolute-standard laboratory-values. In production practice, the unplugged hollow pin is tested in the V-block, and the indicated allowances are made, including the drop in readings due to curvature of the test surface. In this manner many thousands of tests can be made per day.

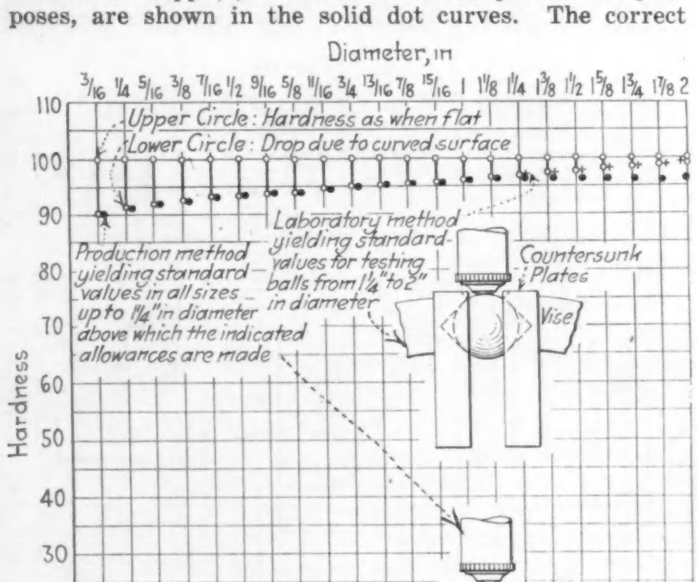


FIG. 8—RESULTS OF ANOTHER SERIES OF TEST OF HARDENED STEEL BALLS OF DIFFERENT DIAMETERS MADE WITH THE RECORDING SCLEROSCOPE

EXTREME UNDER-WEIGHTS

Under-weight samples such as sheets, thin flats, small balls, rods or wire, that can be made to lie flat immediately under the drop-hammer of the scleroscope, will show 100-per cent normal results without clamping them down. The reason is that the weight and impact of the drop-hammer serve to accomplish the clamping without the use of any other means. However, in standard practice, the clamping down of all under-weight samples is necessary, regardless of the size of the piece, to make certain that no air space or intervention of dirt may cause variations in the accuracy of the indications.

As the mass of the test-specimen increases, particularly if it is hardened, and assuming that it is *not* clamped down, when struck by the scleroscope drop-hammer it will be driven down to its supporting base or anvil to form a better contact, and will have a tendency to rebound of itself. This, theoretically, should cause interference with the indications of the drop-hammer. Thus, when the test-specimen is of such a size as to offer the greatest interference, say in the ratio of about 8 or 9 to 1 of the weight of the hammer, it can be said to have a relative critical weight. Then, the precaution of clamping is most necessary.

INERT AND OVER-WEIGHT MASSES

Inert and over-weight masses can be defined as specimens that are approximately in the ratio of more than

25 to 1 of the weight of the drop-hammer. These masses depend less on the anvil for their under-support and are also too inert to react or interfere with the rebound of the hammer. Comparatively, these specimens are easier to mount for obtaining precision results and, if larger, they usually are placed without clamping on an iron bench-plate when tested.

Effect of Hardness on Mass

In the smaller softer metal specimens, the under-support must be the same as for those of hardened steel, but the downward pressure of the clamping means is of less importance, because of the more complete absorption of the shock of the hammer and the decrease of the tendency of the test-specimen to react against the hammer.

Thickness of the Test-Specimen

With the Model-C vertical-scale and with the Model-D dial-recorder scleroscopes, sheets of hardened steel and of the soft metals can be tested down to paper thickness or foils.

In hardened steel, a single specimen that measures less than 0.005 in. in thickness can be tested accurately. In the softer metals, specimens that are of extreme thinness must be piled-up to attain a thickness of 1/50 to 1/32 in., according to the increase of softness. These tests must be made in scleroscope clamping-stands for flats and sheets, as indicated at the left in Figs. 1 and 2. The mass contained in flat specimens, because of the flat anvil-support obtainable in the soft and in the hard condition, has very little influence on the results under either the Model-C or the Model-D scleroscope; this is indicated in Figs. 3 and 4. If the anvil support is very poor, due to lack of flatness of the test-specimen, the mass of the *entire specimen,* if it is of large area, does not necessarily have an influence on the results but, rather, *it is the mass immediately under the drop-hammer,* and extending radially to a diameter of between five and six times the thickness. The flat specimens used for preparing Figs. 3 and 4 were circular in form, $1\frac{3}{8}$ in. in diameter and hardened. Other flats of the same form and series of thicknesses were tested, up to a diameter of $2\frac{1}{2}$ in., and this resulted in a slightly greater correction in the curve of open dots in Fig. 3. When there is considerable lack of smoothness or flatness of plates or flat specimens of hardened steel that have small thickness, and there is doubt that the universal scleroscope is showing the exact value, the samples can be soldered to a larger block of metal and compared with the regular readings, or they can be screw-clamped down with a greater pressure in a holding fixture as shown at the right in Figs. 3 and 4. Another method that provides similar corrective qualities and also is adapted to accommodate tapered pieces, is the rocker flat-anvil illustrated in Fig. 11. It is especially recommended for the Model-C scleroscope.

Testing Near Specimen Edges

On small parallel or flat specimens, little or no difference is noted by testing near the edges if the specimens are clamped properly. On other shapes, such as cylindrical specimens, particularly when these are hollow as in the case of piston-pins, a certain amount of drop in the readings is noted, due to the lack of mass and to improper under-support. However, these errors can be corrected readily on divers shaped pieces by the use of suitable clamping devices as shown in Figs. 3 to 10.

Effect of Curved Surfaces

Curved surfaces can be divided into two classes, rounds or cylindrical surfaces and spherical surfaces. The effect and allowances to be made for the curvature of rounds of hardened steel are illustrated clearly in Figs. 5 and 6. The effect and allowances to be made on spheres or small balls of hardened steel are illustrated in Figs. 7 and 8. These standardized allowances naturally apply to specimens of other cross-sections such as hollow rods, as in Figs. 9 and 10, or to other specimens having similar spherical surfaces that are to be tested. As the hardness runs lower in the scale on all metals, the effect of the curvature is proportionately less. For example, if, in a hardened steel ball that is 100 hard and 13/16 in. in diameter, there is a drop of 5 deg., equal to 5 per cent, in the

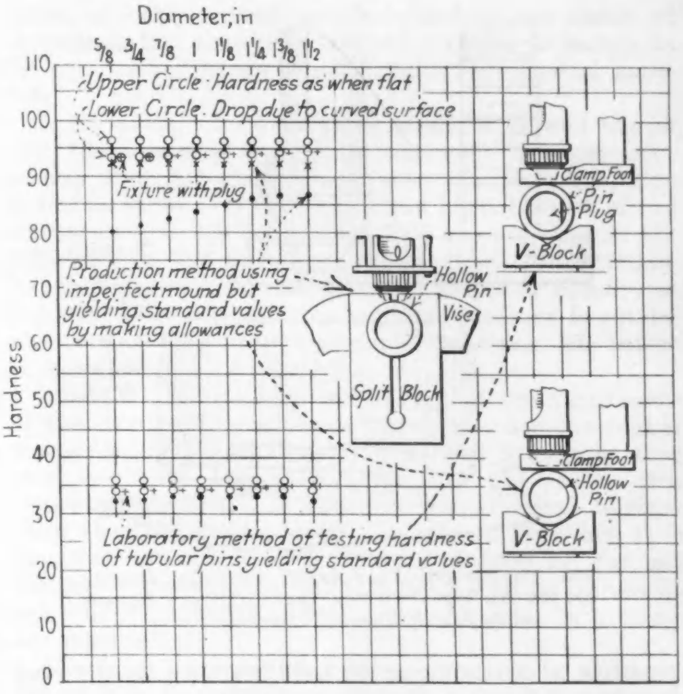


Fig. 9—Results of a Series of Tests Made on Tubular Piston-Pins with the Vertical Scale Scleroscope

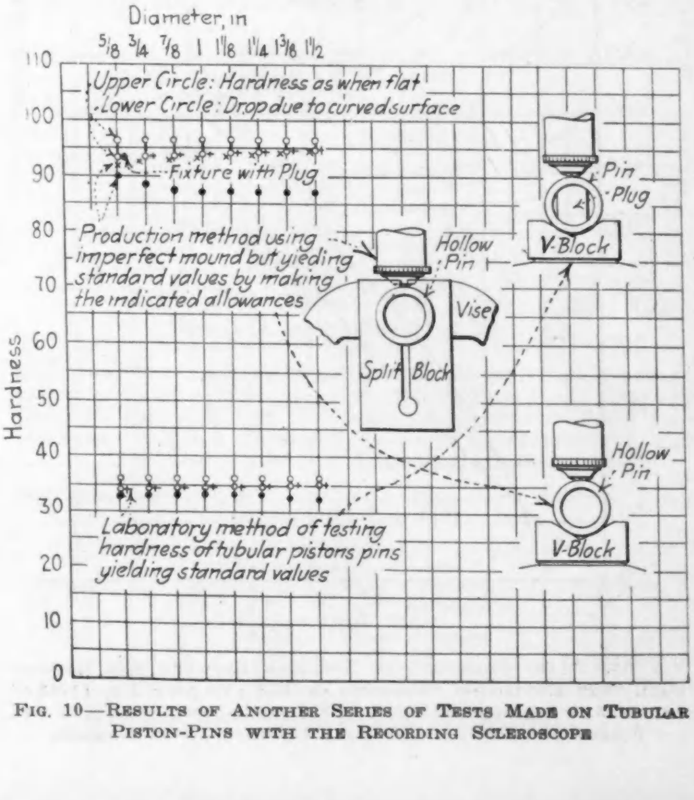


Fig. 10—Results of Another Series of Tests Made on Tubular Piston-Pins with the Recording Scleroscope

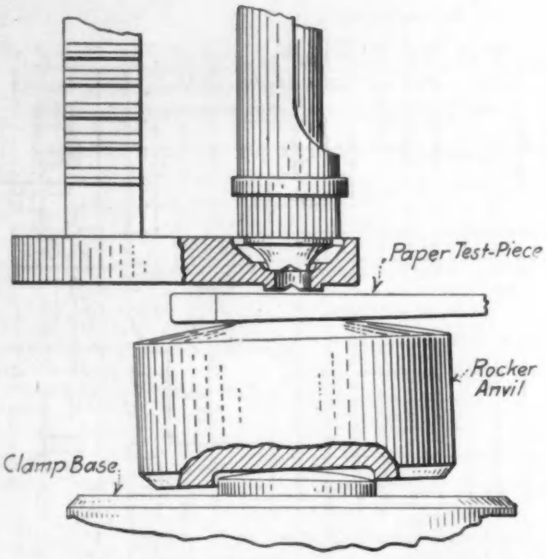


FIG. 11—ROCKER FLAT-ANVIL THAT IS RECOMMENDED FOR USE WITH THE VERTICAL SCALE SCLEROSCOPE WHEN TESTING TAPERED PIECES

readings, at a reading of 50 hard, the drop in the readings is still 5 per cent or 2½ deg.

HOW TEST-SPECIMENS ARE HELD

Unlike other machines for testing the hardness of metals, the scleroscope obtains its indenting force from the fall of its rebounding hammer. Therefore, the specimens can be of unlimited size and the instrument does its work by merely setting it on top of the specimens to be tested. Of the forms not referred to in the illustrations, small reamers and drills can be tested accurately with the Model-D scleroscope in its regular clamping-stand. For reamers, a V-block or a round-grooved block can be used; but drills must be placed on the flat anvil to be tested on the side. If drills are to be tested in quantity, a suitable guide can be attached for holding each size central with the drop-hammer. For testing reamers and drills under the Model-C vertical-scale scleroscope, a split-block fixture in the bench vise is used, as shown by the curves of small oblique crosses in Figs. 9 and 10. These blocks are recommended also for testing these tools under the Model-D scleroscope.

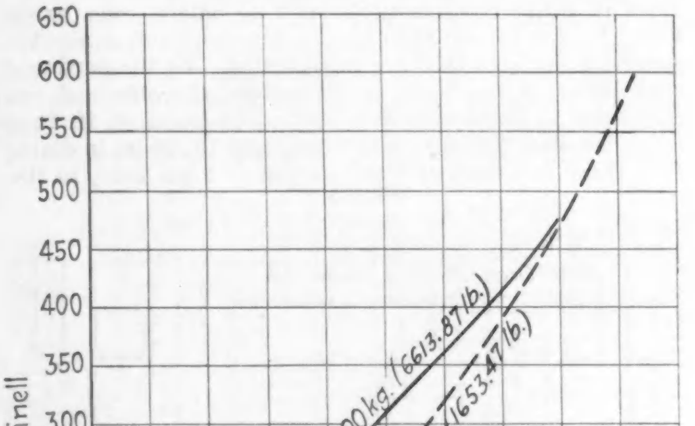


FIG. 12—CHART SHOWING THE RELATION BETWEEN THE BRINELL BALL TEST EMPLOYING PRESSURES OF 750 AND 3000 KG. (1653.47 AND 6613.87 LB.) ON A 10-MM. (0.3937-IN.) STEEL BALL AND THE SCLEROSCOPE USING A UNIVERSAL DIAMOND TIPPED HAMMER

BRINELL AND SCLEROSCOPE-HARDNESS COMPARISONS

In the course of our experience, for a number of years, we have been called upon many times to provide the latest data showing the relation between the values of the ball test and those of the scleroscope. It has always been believed that the Brinell ball-test shows values that bear a relation to the ultimate tension resistance of a metal, while the scleroscope, as we have always claimed and which can be demonstrated, shows a definite relation to the elastic-limit under both tension and transverse stresses.

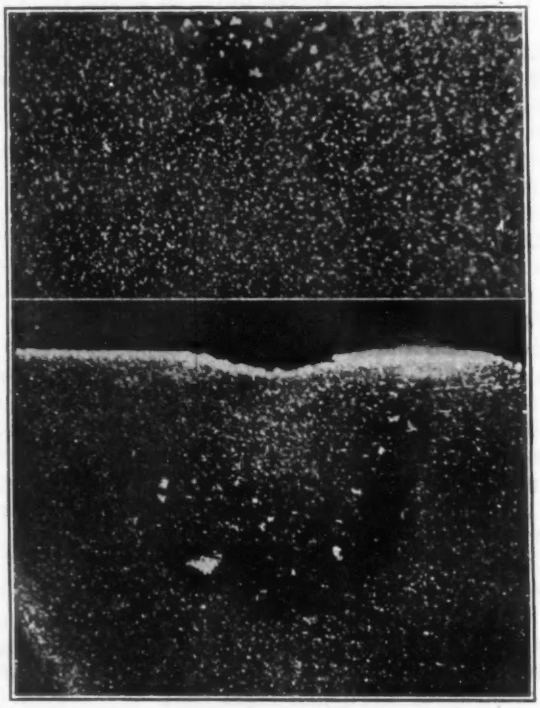


FIG. 13—METALLOGRAPHS SHOWING THE DEPTH OF THE STRAIN ON THE STRUCTURAL CRYSTALS OF A PIECE OF SOFT STEEL SUBJECTED TO THE BALL TEST

The Upper View Is a Vertical Section at the Bottom of the Depression Made by a Ball That Was Subjected to a Pressure of 100 **Kg.** (2204.62 Lb.) and the Lower View Is a Similar Section when the Pressure on the Ball Was 3000 Kg. (6613.87 Lb.) The Steel Tested Had Been Annealed at a Temperature of 650 Deg. Cent. (1202 Deg. Fahr.) for 7 Hr. before the Test Was Made. The Magnification in Each Case Is 6 Diameters

Pursuant to an invitation from Sir Robert Hadfield, I submitted a paper to the Iron and Steel Institute, of London, England, in September, 1918, entitled Relation Between Ball Hardness and Scleroscope Hardness. This treated the subject rather exhaustively. This article was never published and discussed extensively in this Country, and some of its leading features are repeated.

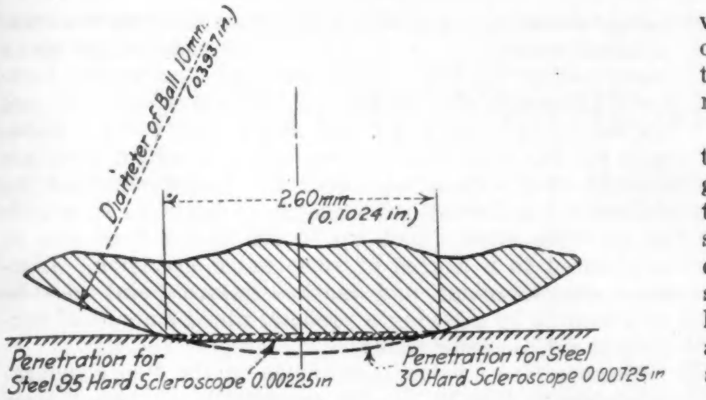


FIG. 14—HOW THE BRINELL STEEL BALL BECOMES FLATTENED WHEN FORCED AGAINST A PIECE OF HARDENED STEEL UNDER A PRESSURE OF 3000 KG. (6613.87 LB.) AND THE MEASURED DEPTH OF PENETRATION FOR THE SAME DIAMETER OF IMPRESSION IN SOFT STEEL

Its principal feature was the conversion chart shown in Fig. 12, from which it is evident that, when a pressure of 500 to 750 kg. is used on a 10-mm. ball in the Brinell machine, a consistent and satisfactory relation with the scleroscope values can be obtained. On the other hand, the full-line curve shows that, by the use of a pressure of 3000 kg., a comparatively irregular curve is obtained, and the agreement with the scleroscope values is comparatively unsatisfactory. In seeking an explanation for the irregularity of the 3000-kg. curve, it was acknowledged to be due to three causes; (*a*) in the lower portion, to the flow of the metal under excessive indenting pressure; (*b*) in the middle portion, to metal flow and super-hardening; and (*c*) in the upper portion, to flattening of the steel ball. The effect of the two respective pressures as developed by Stead's annealing treatment, which indicates the depth of the strain on the structural crystals, is shown in the metallographs, Fig. 14. The flattening of the steel ball on a test-specimen 98 hard by the scleroscope is shown in Fig. 15.

To eliminate the third difficulty (*c*) a superior diamond insert is used in the universal scleroscope drop-hammer which enables it to overcome the resistance of the hardest steel with complete success under many thousands of tests. Hence, in order that the Brinell values might be compared with full accuracy on hardened steels, a ball fashioned from a similar diamond was used on all specimens above 75-hard by the scleroscope. In using this diamond ball, it is not safe to use a load greater than 750 kg. Under this pressure usually only one to three tests can be made; then failure occurs. Under a load of 500 kg. the diamond ball may make from 6 to 12 tests before failing.

Further reference to Fig. 12 will disclose a considerably higher relative value in the 3000-kg. line than in the dotted 750-kg. line, particularly in the steel group between the annealed condition and that of spring temper. Referring to Fig. 16, it would appear that, since the scleroscope symbolizes the tension resistance at the elastic-limit in metals having some toughness, and the ball test agrees very closely with these values when a pressure of 500 to 750 kg. is used on a 10-mm. ball, the higher pressure curve that shows higher hardness-numbers demonstrates that the Brinell test so applied indicates an additional value, namely, that of the ultimate tensile-strength. More recent researches indicate, however, that these higher figures do not, necessarily, represent values beyond the elastic-limit or that they lean toward the ultimate tensile-strength. In fact, in the light of present knowledge, ultimate-tensile-strength values probably cannot be symbolized as the result of one simple test that is so entirely opposite in nature as the one for resistance to compression or physical hardness.

In the group of more ductile steels, it is well known that the ultimate-strength is commonly 100 per cent greater than the elastic-limit, when they are subjected to tensile strain. If we make a ball hardness-test in two stages, such as 500 kg. against 3000 kg. and then let the difference in the calculated values stand for ultimate-strength symbols, we find that an increase, usually, of less than 25 per cent in the hardness readings is obtainable under the higher pressure; whereas, as before stated, it should be nearly 100 per cent.

Further investigations will show that the significance of the calculated hardness-increments under the higher pressures are almost entirely negatived insofar as they may symbolize ultimate-strength, for the reason that comparatively brittle cast-iron is even more apt to show these than the ductile steels. In view of this fact, it is apparent not only that a pressure of 3000 kg. for ball testing is superfluous, but that the resulting values do not really symbolize ultimate-strength and, in general, are misleading.

Therefore, in order that the two recognized hardness-values may be related to meet the general demands, it would seem that the pressure advisable is one that does not exceed 1000 kg. on a 10-mm. ball and with a decrement in several stages, ending in about 25 or 50 kg. for soft lead. The object of this is to eliminate or reduce to a minimum the flow in any of the metals subjected to

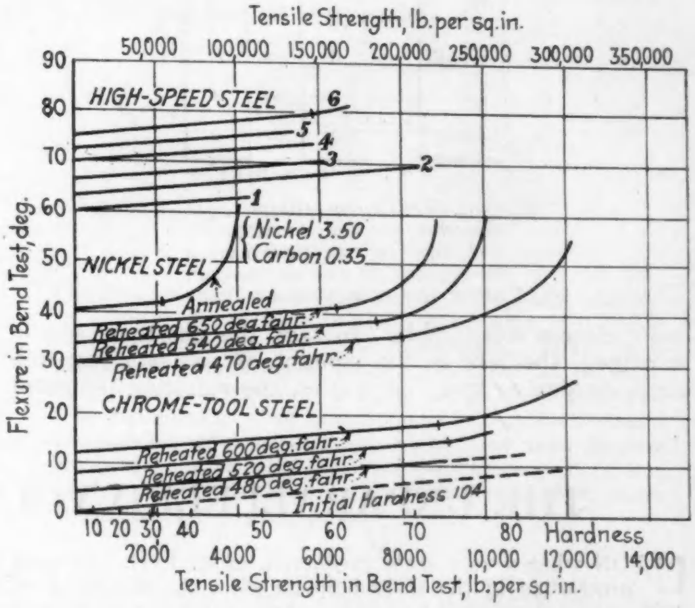


FIG. 15—CHART SHOWING THE RELATION BETWEEN THE HARDNESS AND THE TENSILE-STRENGTH UP TO THE ELASTIC-LIMIT AND THE RELATIVE STRENGTH AND HARDNESS OF CANTILEVER BEND-TEST SPECIMENS HAVING A LENGTH OF 6 TO 1 OF CROSS-SECTION AT THE POINT WHERE THE LOAD WAS APPLIED

The Heat-Treatment for the Various High-Speed Steels Is Given in the Following Table:

Steel No.	Hardening Temperature, Deg. Fahr.	Cooling Medium	Hardness
1............	2,250	Kerosene	99
2............	Rolling Heat	Air	101
3............	2,150	Kerosene	95(*a*)
4............	2,000	Air	84(*a*)
5............	2,150	Air	99
6............	2,100	Air	90

(*a*) These steels were tempered at 650 deg. fahr.

the hardness test. By thus modifying these misleading factors, the time factor becomes such a negligible quantity that static and kinetic classes of tests are rendered

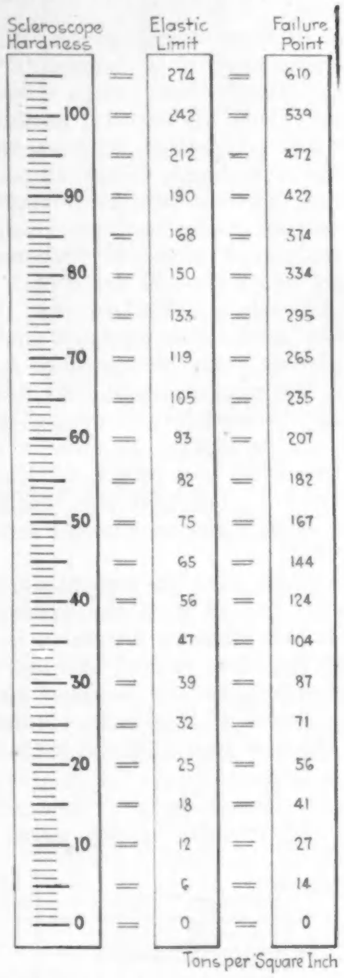


FIG. 16—CHART GIVING THE RELATION OF THE SCLEROSCOPIC HARDNESS TO THE PENETRATION RESISTANCE UP TO THE ELASTIC-LIMIT AND THE FAILURE POINT

more closely comparable. In fact, the less the metal is damaged, the less is the amount of cold-working and super-hardening that follows; so, the resulting indicated values are more faithfully representative of the true and original resistance to compression or indentation which really constitutes the true definition of quantitative hardness. Through the medium of the scleroscope test and for the entire range of metals, making only a slight allowance for the softer non-ferrous alloys in which a certain amount of injury occurs under the drop-hammer of the universal instrument, resistance to penetration in pounds or tons per square inch up to the elastic-limit can be symbolized to a degree of remarkable precision. Likewise, the incipient and marked-failure point can be indicated as by allowing a predetermined amount of permanent set, or penetration.

These relative values are shown in the two comparative tables in Fig. 13. In the preparation of these figures a flat punch under static pressure was used on a flat surface with an allowance of enough margin in the specimen to avoid lateral expansion or possible rupture. The reason is that the compressive resistance per unit of area on such a surface is somewhat greater than it is on a column of the same area as the punch, due to shear resistance of the surrounding uncompressed areas. The guiding influence for the designer and the general serviceability of a properly standardized hardness-test are demonstrated by the rapid failure of the samples as a result of the addition of but slightly more load than that called for in the immunity, or elastic-limit column, of Fig. 13. These values, in tons per square inch, are 45 per cent of those given in the marked-failure-point column. If, instead of this 45 per cent, 50 per cent of the loads indicated in the marked-failure column is applied, immunity ceases and an injury, detectable under a microscope, occurs in the entire range of metals. The amount of set or depression allowed in the marked-failure-point column varies according to the hardness. In steel that is 100-hard, it is about 0.0005 in. In steel that is 50-hard, it is from 0.0010 to 0.0015 in. The depth increases down to the softest metals, in which it is about 0.0150 in. Although the hardness test is one that necessarily is applied to a surface larger than the area under stress, the shear resistance being added, a notable instance in which the hardness test symbolized the columnar resistance only is found in the universal use during the world war of the scleroscope, in this Country and abroad, on steel shells, to determine their resistance to buckling on account of the concussion of the firing charge.

THE UNPARALLELED VOLUME OF FREIGHT TRAFFIC

UPON what a vast scale production of all kinds has been proceeding in the United States since the beginning of 1923 is well illustrated by the fact that, according to reports filed by the railroads of the country with the car service division of the American Railway Association, no less than 33,161,743 freight cars were loaded with revenue freight during the first 35 weeks of the year. This was not only the largest number of cars loaded with revenue freight in any corresponding period in the history of the railroads, but was an increase of 5,564,042 cars, or 20 per cent, over the loadings for the same weeks in 1922. Of the total number for the period this year 19,421,008 cars were loaded with merchandise and miscellaneous freight, an increase of 1,847,808 cars, or nearly 11 per cent, compared with the first 8 months in 1922.

Loadings of grain and grain products in the 8-months' period this year totaled 1,454,744 cars, a decrease of 122,872 cars, or nearly 8 per cent, from the loadings of the same months last year. Live stock loadings, however, totaled 1,119,840 cars, which was an increase of 120,975 cars, or 12 per cent over the figure for the corresponding period 1 year ago.—*Economic World.*

TENTATIVE STANDARDIZATION WORK

Criticism of all tentative reports should be sent to the Standards Committee in care of the Society

BOAT STANDARDS NEEDED

Motorboat Division Initiates Comprehensive Program of Standardization

The Motorboat Division held its initial meeting of the year on Sept. 27 and, in accordance with the consensus of opinion that a real need of standardization in the motorboat industry existed and that a determined effort should be made toward developing standards, it was decided that monthly meetings should be held until the work shall be well under way. A second meeting was therefore held on Oct. 25. Both of the meetings were at New York City as this is the most centrally located city for the Division members.

At the September meeting Charles M. Manly, vice-chairman of the Standards Committee of the Society, acted as chairman. It was decided that engine standardization should be considered by the Engine Division of the Standards Committee with the exception of such matters as are peculiar to motorboat applications. To determine upon a feasible as well as a logical program, the Division devoted both meetings to a general discussion of possible subjects, dividing them into the following general classifications:

- General
- Hull
- Joiner Work
- Fittings, Hull and Deck
- Rudder and Steering-Gear
- Engine, Installation and Equipment
- Lighting
- Ventilation
- Heating
- Plumbing
- Bilge Drainage
- Equipment, Communication and Rigging

It was recognized that it would be better for the Division to select only the most important subjects that could be put into practice without too much resistance, leaving the more difficult subjects until the standardization work shall be well under way.

The Standards Department, to make the work of the Division as effective as possible, was instructed to keep all motorboat builders in close touch with the work of the Division.

BALLOON TIRES DISCUSSED

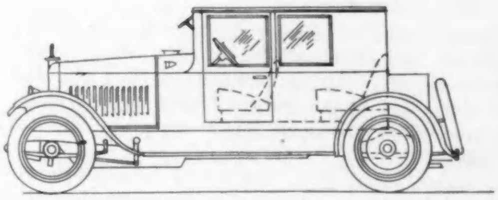
Balloon tire development was discussed at the September meeting of the Tire and Rim Division with special reference to the desirability of having the automobile builders participate in establishing definite standards. The Division went on record as being in favor of establishing suitable standards for balloon tires and rims at an early date to avoid the variety of sizes that would otherwise be developed by the different tire and automobile companies working independently.

It was proposed that arrangements should be made looking toward the holding of a general conference, at which representatives of the Rubber Association of America, the Tire and Rim Association of America, the Tire and Rim Division of the Society's Standards Committee and the National Automobile Chamber of Commerce should discuss standardization possibilities comprehensively.

"COACH" APPROVED AS BODY TYPE

Passenger-Car Body Division Recommends Inclusion in Standard Body Nomenclature

At the meeting of the Passenger-Car Body Division in September, it was proposed to extend the present standard nomenclature for passenger-car body types to include the "coach" type of body. Although the desirability of recommending the use of this name, which has been popularized during recent years was discussed at some length, it was found impossible to suggest a better name that would be descriptive of the type of body in mind. The accompanying definition and illustration were approved by the Division for publication in the S. A. E. HANDBOOK under Automobile Nomenclature, Division XVIII, Types of Body, provided such action shall be approved by the Society in accordance with its usual standardization procedure.



Coach.—An enclosed single-compartment body, similar in general appearance to the sedan, with two close-coupled cross-seats for four passengers. There is a luggage compartment or space for a trunk at the back of the body. There is no glass in the rear quarters. The conventional type has two doors only, the forward seats being divided and the right-hand seat tipping forward to give access to the rear cross-seat. Some models have two doors on the right-hand side, there being two fixed cross-seats.

TESTING HEAD-LAMP VOLTAGE

Special Committee Appointed to Determine Uniform Method

A special Subdivision was appointed by Chairman McKay at the September meeting of the Lighting Division to formulate a uniform method of testing head-lamp voltage as well as to cooperate in securing data on existing practice. J. H. Hunt, of the General Motors Research Corporation, was appointed chairman, the other members being C. A. Atherton, A. L. Lewellen, P. R. Moffett, O. W. A. Oetting, L. C. Porter and Herman Schwarze.

The appointment of the committee was the result of the attention that the Lighting Division members have given to the high-voltage conditions that obtain in the lighting cir-

cuits of several makes of automobile, especially during winter operation. Information was submitted at the September meeting which showed that the voltage at the head-lamps also varies considerably in new cars.

The suggestion that the lamp manufacturers should make 6-volt lamps in two ranges of voltage so that it would be possible for automobile owners experiencing high-voltage conditions to obtain high-voltage lamps was considered impractical. It was stated that it would be impossible for the distributors throughout the Country to carry the additional stock necessary, or to indicate to automobile owners which type of lamp they should purchase.

ALUMINUM SHEET SIZES PROPOSED

Passenger-Car Body Division Considers 12 Satisfactory for General Application

Although the present S. A. E. Non-Ferrous Metals Specifications include specifications for aluminum sheet and strip, with respect to both chemical and physical properties, no attempt has been made hitherto to standardize on a limited number of sheet sizes.

Appreciating that the body industry would gain through the elimination of many odd sizes of sheet, the Passenger-Car Body Division at its September meeting decided to recommend the adoption of 12 sheet sizes for general body applications. The sizes proposed are given in the accompanying table.

ALUMINUM SHEET SIZES PROPOSED AS STANDARD

No. 14 *Gage*	*No.* 16 *Gage*
24 x 72 in.	24 x 72 in.
30 x 96 in.	30 x 96 in.
36 x 120 in.	36 x 120 in.
36 x 144 in.	36 x 144 in.
48 x 144 in.	48 x 144 in.
60 x 120 in.	....
60 x 144 in.	....

The recommendation does not include any sheet of No. 15 gage because the demand for sheets of this thickness is not large relatively. It is recognized that the list of sizes proposed does not cover general practice entirely, but the sizes recommended are considered adequate for future production needs.

It was appreciated that the large producers of automobile bodies will not use always the sizes recommended, owing to the fact that a special size is often warranted if purchased in large quantities. But it is considered that the smaller body-producers could adhere to the proposed standard very advantageously. The Division recommended that the following footnotes be included as part of its recommendation.

> Aluminum sheet of No. 14 gage may be obtained in tempers Nos. 4 and 6. Sheet of No. 16 gage can be obtained in temper No. 6 only.
>
> "Commercial" or "bright finish" product is finish-rolled in polishing rolls.
>
> Gray plate is not finished in finishing rolls and is not recommended for stamping.

As the sizes proposed by the Division are now carried in stock by the manufacturers, the recommendation of the Division will not result in making it necessary to carry additional sizes in stock while the standard sizes are being put into practice.

SCREW-THREADS REPORT APPROVED

Society to Act on Sectional Committee Report on Screw-Threads at Annual Meeting

At the meeting of the Screw-Threads Division in September, it was recommended that the report of the Sectional Committee on the Standardization and Unification of Screw-Threads should be approved by the Society as a joint sponsor.

The Sectional Committee on the Standardization and Unification of Screw-Threads was organized under the regulations of the American Engineering Standards Committee to review the report of the National Screw Thread Commission, on which the American Society of Mechanical Engineers and the Society of Automotive Engineers are the two civilian participating organizations, with a view of establishing a definite report which could be adopted as an American Standard. In accordance with the rules and regulations of the American Engineering Standards Committee, the report of the Sectional Committee must be approved by the sponsor organizations, the American Society of Mechanical Engineers and the Society of Automotive Engineers, before it can be acted upon by the Main Committee of the American Engineering Standards Committee. The American Society of Mechanical Engineers has already approved the report of the Sectional Committee and, as a result of the action of the Screw-Threads Division, the matter of approval by the Society of Automotive Engineers will be brought up for action at the Annual Meeting of the Society.

Inasmuch as the report of the Sectional Committee covers classes and fits that are not used in the automotive industry, such as the loose-fit class for screws with the neutral zone definitely placed, the Screw-Threads Division will recommend at the Standards Committee meeting certain parts of the Sectional Committee Report for adoption as S. A. E. Standard. The Society members will therefore have available in the S. A. E. HANDBOOK all screw-thread data applicable to automotive engineering.

It is recognized that the Sectional Committee Report does not cover all possible screw-thread applications, but is intended primarily for fastening units such as screws, bolts, studs and nuts. The Screw-Threads Division is therefore working concurrently with the National Screw Threads Commission in developing a recommendation for tolerances for lengths of engagement up to 3 in.

REVISED ALUMINUM STANDARD PROPOSED

Non-Ferrous Metals Division Proposes Revision of S.A.E. Specification No. 78

The Non-Ferrous Metals Division is considering a revision of the present specification for aluminum sheet and strip printed on p. D121 of the S. A. E. HANDBOOK, as proposed by Chairman Jeffries. The principal change suggested is the specifying of four instead of three tempers. The present specification revised as proposed follow:

SPECIFICATION NO. 78 ALUMINUM SHEET AND STRIP

> *Composition in Percentage.*—Aluminum, min., 99.00.
>
> *Physical Properties.*—Aluminum sheet or strip is furnished in several tempers or degrees of hardness. These tempers or degrees of hardness are indicated by the reduction in thickness produced by cold-rolling after annealing and are expressed in terms of the number of American-wire-gage sizes included between the original and final thicknesses. Thus, "Temper No. 4" indicates that the thickness of the sheet or strip after annealing was 4 gage-numbers more in thickness, having been reduced to size by cold-rolling. "Temper No. 0" indicates that the sheet or strip is in the soft annealed state. "Hard temper" indicates that the sheet or strip has been reduced in thickness after annealing by 12 or more gage-numbers. The mechanical properties of aluminum sheet or strip of tempers Nos. 0, 4 and 6 and hard temper are given in the accompanying table.
>
> The tensile test-specimen shall be cut from the sheet or strip parallel to the direction of rolling. The bend test-specimen may be cut without regard to the direction of rolling. Sheet or strip of tempers Nos. 0 and 4 shall withstand being bent-cold flat upon itself, with-

out cracking. Although tensile tests of sheet or strip of temper No. 6 indicate an elongation only slightly greater than that of the hard temper sheet, it is considerably more ductile, as is evidenced by the fact that it will withstand cold-bending through an angle of 180 deg. around a diameter equal to twice the thickness of the sheet, without cracking. Hard aluminum sheet or strip will not endure any considerable amount of bending without cracking, especially in the thicker gages.

PHYSICAL PROPERTIES OF ALUMINUM SHEET AND STRIP

Temper	Thickness				Minimum Tensile-Strength, Lb. per Sq. In.	Minimum-Elongation in 2 In., Per Cent
	A.w.g.		In.			
	From	To, Incl.	From	To, Incl.		
0 (Soft)	2	9	0.258	0.114	12,000	30
	9	16	0.114	0.051	12,000	30
	16	20	0.051	0.032	12,000	25
	20	24	0.032	0.020	12,000	20
	24	28	0.020	0.013	12,000	15
4	6	9	0.162	0.114	16,000	7
	9	16	0.114	0.051	16,000	7
	16	20	0.051	0.032	16,000	5
	20	24	0.032	0.020	16,000	4
	24	28	0.020	0.013	16,000	3
6	10	16	0.102	0.051	18,000	5
	16	20	0.051	0.032	18,000	3
	20	24	0.032	0.020	18,000	2
	24	28	0.020	0.013	18,000	2
Hard	10	16	0.102	0.051	22,000	4
	16	20	0.051	0.032	24,000	3
	20	24	0.032	0.020	26,000	2
	24	28	0.020	0.013	30,000	1

PERMISSIBLE TOLERANCES

Thickness				Permissible Tolerance, Plus or Minus, In.
A.w.g.		In.		
From	To, Incl.	From	To, Incl.	
2	4	0.258	0.204	0.0100
4	9	0.204	0.114	0.0060
9	13	0.114	0.072	0.0030
13	21	0.072	0.029	0.0025
21	24	0.029	0.020	0.0020
24	28	0.020	0.013	0.0015

General Information—The specific gravity of aluminum sheet and strip is about 2.70. Young's modulus of elasticity is about 10,000,000 lb. per sq. in. Aluminum sheet or strip is used for many purposes where the requirements either as to service or as to the forming operations are too specific to be covered in any general specification. It is usually advisable therefore to submit samples or drawings to the manufacturer to assist in the selection of the proper temper for the service or forming operations.

Aluminum sheet or strip is used for automobile bodies, hoods (special flat sheet), fenders, housings, floor coverings, molding, instrument parts, instrument-boards, hub-caps, wire-wheel discs, brake-drum covers, miscellaneous pressings, and for many parts used in aircraft construction

BRAKE-LINING TESTS DISCUSSED

Improved Machines Developed by Brake-Lining Subdivision Members

At the meeting of the Brake-Lining Subdivision held in New York City on Oct. 9, the recent work of the Division members in determining suitable tests for brake-lining was discussed in detail. Clarence Carson, chairman of the Subdivision, submitted blueprints of a machine that he had designed recently as a result of his experience with a brake-lining testing-machine similar to the one developed by S. von Ammon at the Bureau of Standards, which was described in detail in the paper presented by the latter, entitled Developing a Method for Testing Brake-Linings, at the 1922 Annual Meeting of the Society.

Members of the Brake-Lining Subdivision Who Attended the Meeting Held at New York City on Oct. 9

Mr. von Ammon described another testing-machine that had been developed at the Bureau of Standards as a result of experience with the original machine developed there. Although these new testing machines differ somewhat as to principles of construction, it is felt that the results obtained from them would be of considerable value.

Articles describing the new testing machines will be included in early issues of The Journal.

Those present at the meeting were Clarence Carson of Dodge Bros., S. von Ammon of the Bureau of Standards, H. R. Cobleigh of the National Automobile Chamber of Commerce, J. Driscoll of H. W. Johns-Manville Co., C. E. Harwood of the Russell Mfg. Co., W. S. James of the Bureau of Standards, W. H. Morris of the Keasbey & Mattison Co., C. F. Ogren and W. D. Pardoe of the Thermoid Rubber Co., R. H. Soulis of the Multibestos Co., H. R. Wolf of the General Motors Research Corporation and Standards Manager R. S. Burnett.

REVISED TIRE-STANDARDS PROPOSED

Tire and Rim Division Cooperating with Tire and Rim Association of America

On Sept. 27 the members of the Tire and Rim Division held a meeting in Cleveland at which the existing S. A. E. Standards and Recommended Practices for tires and rims were reviewed and definite revisions suggested. All the members of the Division, which consists of J. G. Vincent, chairman; B. B. Bachman, A. J. Scaife and H. M. Crane, were present with the exception of Mr. Crane. Alex Taub of the General Motors Corporation, G. L. Lavery of the Tire and Rim Association of America, C. B. Whittelsey, chairman of the Tire and Rim Division for several years, General Manager Clarkson and Standards Manager Burnett were also present. The Division, which is working closely with the Tire and Rim Association of America and the Rubber Association of America, will submit definite recommendations covering the proposed revisions at the Annual Meeting of the Standards Committee. As the tire and rim standards in Section G of the S. A. E. Handbook have not been revised for several years, the action taken, which is outlined hereinafter, will be of special interest.

Pneumatic Tires and Rims

With the addition of the 31 x 4-in. regular tire and rim size, the proposal of the 1922 Tire and Rim Division was considered to provide a suitable range for practically all passenger-car requirements. A recommendation was therefore made that the present S. A. E. Standard for Pneumatic

Tires and Rims, p. G1 of the S. A. E. Handbook, be revised to conform to the revised proposal of the 1922 Division. The present standard, revised as proposed by the Division, is given in the accompanying table.

PROPOSED STANDARD SIZES OF PNEUMATIC TIRES AND RIMS

Type	Nominal Rim		Nominal Tires		Tire-Seat Diameter, In.
	Size	Type	Regular	Oversize	
Passenger Cars	30x3½	C	30x3½	31x4	23
	30x3½	SS	....	31x4	23
	31x4	SS	31x4	....	23
	32x4	SS	32x4	33x4½	24
	32x4½	SS	32x4½	33x5	23
	34x4½	SS	34x4½	35x5	25
Motor Trucks	34x5	SS	34x5	36x6	24
	36x6	SS	36x6	38x7	24
	38x7	SS	38x7	40x8	24
	40x8	SS	40x8	42x9	24
	44x10	SS	44x10	....	24

C—Clincher Type.
SS—Straight-Side Type.

Pneumatic-Tire Rim Sections

Since it was felt that the detailed rim dimensions are not of special interest to the Society members, it was proposed that the present S. A. E. Standard for Pneumatic Tire and Rim Sections, p. G2 of the S. A. E. Handbook, should be revised in accordance with the present standards of the Tire and Rim Association and reprinted as general information only.

Pneumatic-Tire Felloe-Bands

As it was considered that the scope of the Tire and Rim Division should include only tire and rim matters, it was proposed that the S. A. E. Standard for Pneumatic-Tire Felloe-Bands, p. G4, should be withdrawn and further action in the connection referred to the Axle and Wheels Division.

Rim Clamp-Bolts

It was noted that the numbers of bolts specified for the various sizes of rim were not in accord with present practice, and in view of the action taken on pneumatic-tire felloe-bands the matter of revising this standard was also referred to the Axle and Wheels Division.

Solid Tires

It was proposed that the present S. A. E. Standard for Solid Tires, p. G10, should be brought into conformity with the solid-tire standard of the Rubber Association of America.

Solid-Tire Base-Bands

Similar action in reference to the S. A. E. Standard for Solid-Tire Base-Bands, p. G11, was taken.

Carrying Capacities and Inflation-Pressures of Pneumatic Tires

Since the S. A. E. Standard for Carrying Capacities and Inflation-Pressures of Pneumatic Tires, p. G6, is primarily of interest to the tire manufacturers, being intended to regulate operating conditions, it was proposed that the present standard should be withdrawn and the table of carrying capacities and inflation-pressures adopted by the Tire and Rim Association published as general information only in Section G of the S. A. E. Handbook as the standard of that association.

Deflection and Set Test for Pneumatic-Tire Rims

As the S. A. E. Standard for Deflection and Set Test for Pneumatic-Tire Rims, p. G6, is intended for use only by the rim manufacturers, the Division recommended that the standard should be withdrawn.

Felloe Bands

In accordance with the action limiting the scope of the Division's work to tire and rim matters, work relating to modification of the present S. A. E. Standard for Felloe-Bands, p. G7, was referred to the Axle and Wheels Division.

Wood Felloes for Pneumatic-Tire Rims

The subject of revising the present S. A. E. Standard for Wood Felloes for Pneumatic-Tire Rims, p. G8, was also referred to the Axle and Wheels Division. It was noted that a similar specification for steel felloes would be of value to the industry.

Motorcycle CC Rims

In conformity with the action taken on pneumatic-tire rim sections, it was proposed that the present S. A. E. Recommended Practice for Motorcycle CC Rims, p. G9, should be revised to harmonize with the specifications of the Tire and Rim Association of America, and reprinted in Section G as general information only, with reference to the recommendations of the Tire and Rim Association of America.

Motorcycle Tires

The Division recommended that the present S. A. E. Recommended Practice for Motorcycle Tires, p. G9, be brought into agreement with the corresponding standard of the Tire and Rim Association of America and proposed for adoption as S. A. E. Standard, if this shall be satisfactory to the motorcycle manufacturers.

Solid-Tire Felloe-Bands

The matter of further consideration of the standard for Solid-Tire Felloe-Bands, p. G12, was referred to the Axle and Wheels Division.

Solid-Tire Demountable Rims

As the present S. A. E. Recommended Practice for Solid-Tire Demountable Rims, p. G14, is obsolete, it having been continued in recent years owing to the fact that some special equipment was still made in accordance with this standard, it was proposed that it should be withdrawn.

Industrial-Truck Tires

No new action was taken on the S. A. E. Standard for Industrial-Truck Tires, p. G16. It was suggested that a conference be held with the Rubber Association of America as to the commercial status of this standard.

GERMAN BANK FUNDS

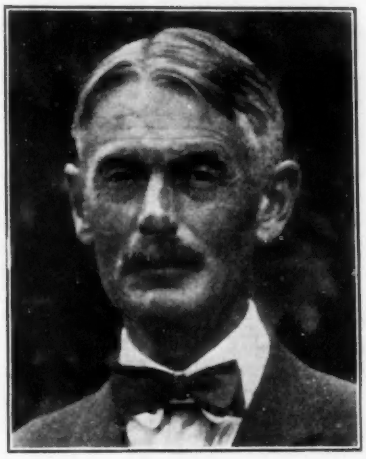
TOTAL deposits of German banks, including savings institutions, at the end of 1922 were estimated at about 3,000,000,000 gold marks, as compared with 8,500,000,000 gold marks at the end of 1921 and about 20,000,000,000 gold marks of savings banks alone in 1913. The decline in deposits of banks expressed in gold marks corresponds to the general policy of German business men to keep with banks only an absolute minimum of their liquid funds in paper marks and to convert the rest into foreign exchange, real estate or other tangible assets whose value is not affected by the depreciation of the mark. The increase in deposits with banks abroad, coupled with the decline in paper mark holdings, clearly indicates the general policy of banks and commercial houses to emancipate themselves from the paper mark and to convert their assets into values not subject to depreciation.—*Economic World.*

MEETINGS OF THE SOCIETY

BRAKE DESIGN AND CONSTRUCTION

H. M. Crane Presents Fundamental Principles at Metropolitan Section Session

A bumper meeting of the Metropolitan Section was held on Oct. 18, well over 200 persons being present. Henry M. Crane, in a paper that is printed elsewhere in this issue of THE JOURNAL, presented facts that he considered of importance in connection with brake design, his observations being the result of nearly a score of years of experience. He presented a curve showing that the braking effect of the engine is greater when the throttle is closed. The condition he referred to was one in which the throttle was really closed, and in which the switching-off of the ignition would not increase the braking effect.



H. M. CRANE

Mr. Crane stated as the crux of the whole brake question the securing of the result desired most directly and with the least mechanism. He exhibited drawings that showed the principles of practice he described. He also showed a fabric type of band that was glazed rather than worn after 60,000 miles of service in a transmission brake of a passenger-car that was not run at high speed and with which the engine was used in high-gear as a brake. The brake was oiled from time to time, this making its action smoother and keeping the binder of the fabric in good condition. Mr. Crane stated that this band was probably good for 50,000 miles of additional service.

In the discussion, A. L. Clayden said that in the case of brakes, as of most other components of cars, the principal thing is the merit of the design and the construction. A simple design gives the best results. The tendency has been toward a complicated structure. He expressed the opinion that no one place on a car is better than another from which to retard the motion of the car. The principal difference in the condition with four-wheel brakes is that there is more braking area.

Chairman Cornelius T. Myers expressed the view that brakes have been a weak element and that the agitation in connection with four-wheel brakes will result in the improvement of brakes in general.

R. E. Fielder said that in motorbus operation the braking area is an important element and that four-wheel brakes are necessary. R. W. A. Brewer was of the opinion that the difficulty is to get a braking surface that can be relied on, the ordinary type of braking fabric varying greatly in its effectiveness from time to time.

C. J. Everett felt that brake designers pay too little attention to kinematics, and that as a consequence in some constructions the brakes become set when driving uphill and released when descending a grade. R. M. Werner referred to his experience in encountering this same condition. Harold Nutt advocated strongly the use of four-wheel brakes for reducing the number of fatal accidents in city driving. Charles M. Manly said that the most important point to consider in connection with the desirability of installing four-wheel brakes is how the energy of the moving car can be absorbed most effectively on slippery streets; and that the determination of this matter is largely the criterion as to the necessity for four-wheel brakes. The rear-wheel brakes are adequate if they will meet the conditions outlined. President Erskine, of the Studebaker Corporation, sent a communication calling attention to the statement of disadvantages of four-wheel brakes as set forth in the advertising of that company.

In replying to discussion and questions, Mr. Crane said that there is no doubt of the necessity of brakes being easily adjustable and that it is possible to accomplish this, as well as good accessibility, in a simple design; that in braking with the engine backfiring in the muffler can be avoided if the carbureter adjustment is correct; and that the selection of the best material for band brakes is determined largely by how good a brake is desired and how much room there is to install it. Furthermore, that the fabric with which he had had most experience was straight asbestos with woven wire, and that in his opinion molded lining, while suitable for brake-shoes, is not suitable for bands. He advised oiling the transmission brake if it is properly protected. In this case, however, there must be a greater leverage to offset the condition. In braking with the engine, the leading factors are engine friction and the pumping loss, this accounting for the greater effect of engine braking with the throttle closed. It is difficult to secure a high enough coefficient of friction with metal-to-metal brakes. This arrangement may be used in a transmission brake if the temperature of the brake does not become too high.

At the Nov. 15 meeting of the Metropolitan Section, Prof. E. P. Warner will present a paper on Commercial Air Travel.

UNCONVENTIONAL ENGINE VALVES

Three Experimental Types Described at Meeting of the Detroit Section

ABOUT 150 members attended the first fall meeting of the Detroit Section on Oct. 4 at the General Motors Building, Detroit. Papers describing new departures in valve design were presented by O. D. Heavenrich, Guy Disc Valve Motor Corporation, Ypsilanti, Mich., and Eugene Bournonville, Bournonville Rotary Valve Motor Co., Jersey City, N. J. Mr. Heavenrich described a Rotary Disc Valve Engine, built by his company, and Mr. Bournonville discussed Rotary Valves for Internal-Combustion Engines. R. Abell, general

THE 1923 PRODUCTION MEETING

Will Be Found Described in This Issue of THE JOURNAL on p. 429

manager of the Single Valve Engine Co., Mattapan, Mass., who recently read a paper on Single-Valve Internal-Combustion Engine Design and Operation[1] before the New England Section, talked extemporaneously, illuminating some of the important features of his paper.

A Rotary-Tube Valve Engine

Eugene Bournonville

Mr. Bournonville, in reviewing the early efforts to perfect a rotary valve, said that about 2500 patents had been taken out but that for the most part they were freakish in design, had no reliable means of automatic and fool-proof lubrication, and that no successful attempt was made to take care of the expansion and the contraction of the parts coming into contact with the ignited gases.

He said that in investigating the subject he had devoted his attention first to expansion and contraction. As the conductivity of heat through metals is very rapid a valve was designed having very heavy walls so that local heating was almost impossible, and uniform expansion of the valve was obtained. To keep the valve cool relative to its casing the carbureted mixture was made to pass from the carbureter through bored holes in the center of the valve. The gas, leaving both ends of the valve, enters a passage extending the full length of the valve head, and this passage, being open on one side, exposes one-sixth of the entire surface of the valve to the wet mixture, thus serving to cool as well as to lubricate it. At first, lubrication was effected by mixing 1 pint of light lubricating oil with 5 gal. of gasoline. While experimenting with a Fiat engine he found that the use of a rotary valve increased the speed from 55 to 65 m.p.h. and the miles per gallon of gasoline from 9 to 12½. This car has covered over 70,000 miles since that time without the valve's requiring any attention whatever.

In his first experiments with a rotary valve on a Willys Overland engine, though the horse-power at 1000 r. p. m. was increased from 28 to 32, when the speed was increased to 2000 r. p. m. the valve seized and the engine was ruined.

After building 25 engines during the last 12 years, a self adjusting valve has finally been perfected that takes care of expansion and contraction and the wear of the valve in its casing.

The main points that must be provided for to operate a practical rotary valve engine properly are as follows:

(1) Uniform contraction and expansion of the valve and its casing

(2) An automatic and dependable oiling system

(3) Constant contact between the valve and its casing

(4) Automatic adjustment for controlling the results of expansion and contraction of both the valve and its casing

(5) Means of taking care of the wear of the valve and its casing automatically throughout the life of the engine

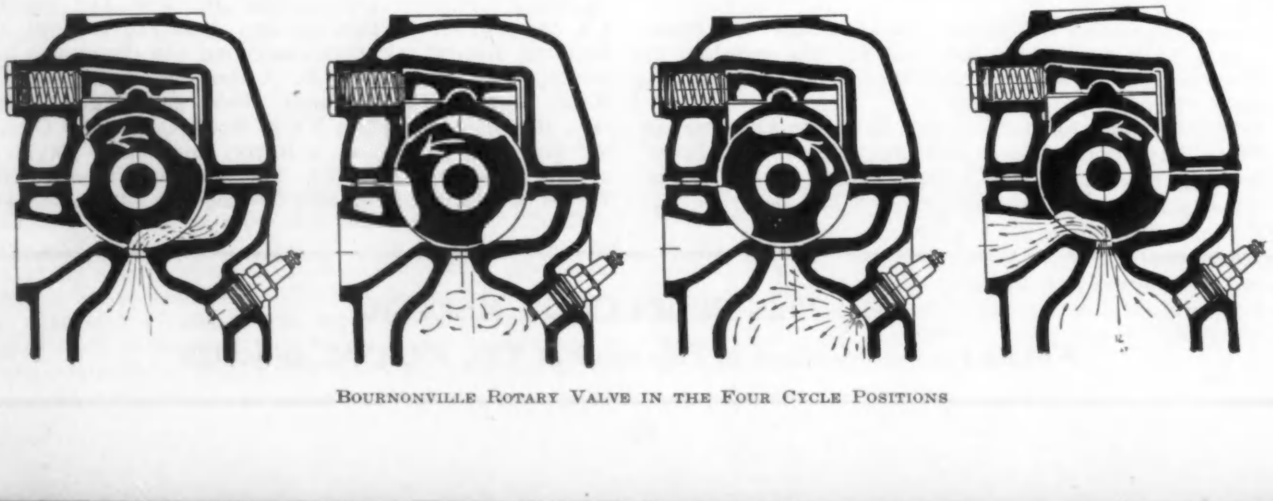
(6) There must be absolutely no clearance between the valve and its casing, while at the same time friction must be eliminated to such an extent that no undue loss of power will occur

[1] See The Journal, October, 1923, p. 301.

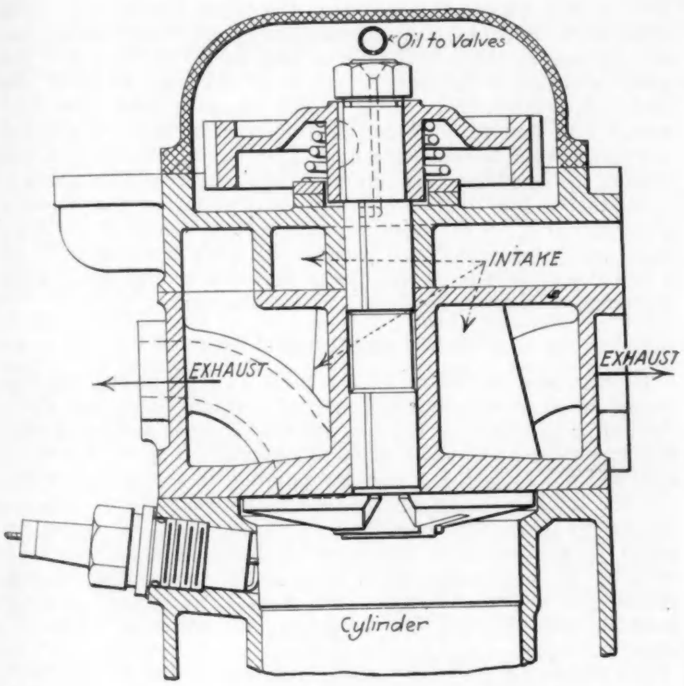
Rotary-Disc Valve Engine

Calling attention to the great amount of experimental work that has been done in recent years toward developing a valve mechanism that will do the work of the poppet valve without making so much noise, Mr. Heavenrich said that probably the best known non-poppet valve engine was that using the double reciprocating sleeve, but that this type, while giving excellent service, necessitated a considerable amount of accurate machine work and that proper lubrication was a problem. Another engine, less well known, has a single sleeve with a combined reciprocating and revolving motion. Other types of piston-valve and rotary-sleeve engines, and those having revolving cylinders, revolving pistons, rotary plug valves, rotary disc valves, and the like, usually are either too complicated, or too expensive to be practical. The engine most closely resembling his own was the Reynolds rotary valve engine, built a few years ago in Detroit.

The engine under discussion is not of the poppet valve, sleeve valve, rotary plug-valve type, nor any combination of them. The valve was said to be a cast-iron disc, machined flat on one side and having four equally spaced radial slots or ports. It is mounted on the lower end of a stem that comes through the head and turns the valve continuously in one direction against the bottom face of the cylinder-head, which contains the intake and the exhaust-ports. One valve is used in each cylinder, alternately opening the four exhaust and the four intake-ports in the cylinder-head and operating at one-eighth the speed of the crankshaft. A feature of the valve is a flexible connection to the valve-stem that allows the valve enough wabble to take care of any slight misalignment in machining, or in clearance around the valve-stem, while still maintaining a seal against the pressure in the cylinder. The valve is driven by a square key, fixed in the end of the stem and fitting into a keyway milled across the boss on the under side of the valve. The valve-stem is turned by a plain cast-iron spur-gear on the upper end of the stem above the head, the gear train being protected by an aluminum cover. In four- and six-cylinder engines, the drive is taken from the front end by a horizontal shaft that runs as far back as the center main bearing. At this point it operates, by worm or spiral gears, a vertical shaft running at one-eighth of the crankshaft speed. The whole valve-mechanism is most satisfactorily quiet. There are no reciprocating parts, no intermittent motions, nothing to clatter.



Bournonville Rotary Valve in the Four Cycle Positions



GUY ROTARY DISC VALVE CONSTRUCTION

Each part has a continuous rotary motion and is always in metal-to-metal contact with its neighbor, so that even with poorly machined or badly worn parts the same quietness of operation prevails. No figures as to the amount of power required to operate the valve have been obtained, but the driving sprocket is held in place at the front of the driving shaft by a ¼-in. Woodruff key, unassisted by a clamping nut, and has given no trouble. The whole valve-mechanism, when set up ready for running, can easily be turned by hand, the only load being the friction load caused by the springs holding the valves in their seats.

ADVANTAGES CLAIMED FOR DISC VALVE

Among the advantages claimed for the disc valve over both the poppet valve and the sleeve valve are the following:

(1) Continuous metal-to-metal contact and absence of reciprocating parts make an essentially quiet drive

(2) It compares exceptionally well in the matter of holding compression, its flat surface being maintained in contact with a flat seat by the pressure of a light spring at the top of the stem and by the pressure in the cylinder

(3) There is no problem of expansion and contraction. Any expansion is taken up in the spring and the efficiency of the valve is the same whether the engine is hot or cold

(4) Disc valves are not ground or lapped in. The filler of carbon and oil that forms after a few hours' running makes an ideal seat. Trouble due to the warping of the valves that was encountered during the early experimental stages was ended when the ribs that had been used for stiffening were cut off. Heat-treated alloy-steel valves do not work as satisfactorily as cast iron

(5) The under side of the valve forms part of the combustion chamber and carbon collects on it, as on any other part of the chamber, but is immediately rubbed off the working surface

(6) Notwithstanding that they are subjected to intense heat, the edges of the valve ports remain sharp, for the valve is at all times in contact with its water-cooled seat

(7) Lubrication of the valve is taken care of by gravity

(8) As four columns of gas rush in through four ports and gradually change their direction as the ports close, a beneficial condition of turbulence is set up; the four exhaust-ports situated in the head of the combustion-chamber also give excellent scavenging

(9) Any desired timing of the valves can be obtained; as the valves set directly over the centers of the cylinders the valve capacity is limited only by the distance between the centers

(10) The cost of construction in quantity production should compare favorably with that of any other type. All parts are easily machined, no special materials are required and the small number of parts cuts down assembling costs

(11) As a simple horizontal shaft is used to carry the drive, instead of a camshaft, it can be used to take care of some of the accessories

COMBINED POPPET AND DISTRIBUTOR VALVE TYPE

R. ABELL

In opening the discussion, Mr. Abell showed some lantern slides of the engine described in his paper. The engines developed by Mr. Heavenrich and Mr. Bournonville, he said, were without poppet valves; that which he described had one poppet valve for each cylinder and a rotary distributor in series with it. The distributor is so called because it is subjected to neither compression nor explosion pressures, but serves only as a deflector in the manifolds, and switches from the exhaust to the intake-port when the piston is going over top center at the end of the exhaust stroke. In this position the valve is wide open and the cam, which has a long dwell, is exactly midway in the travel in that dwell. In two-valve engines the difficulty in closing the valves positively is that the exhaust-valve is under minus pressure, which tends to pull the valve from its seat and destroy the mixture, especially when operating at low throttle. This condition does not obtain with the single-valve engine because the valve is wide open and because of the rotary distributor. The outstanding feature of the engine is the combustion and the thermal gain in the temperatures at which the engine operates, as well as its ability to operate and hold its port at a high range of speeds. Another advantage is that the hemispherical combustion-chamber presents the minimum of heating surface to the flame and at the same time has the maximum of cooling surface in contact with the water because the chamber is interrupted with only one port. The valve serving both exhaust and intake is kept at moderate heat, the maximum temperature at the edge of the valve being about 500 deg. fahr. under any condition of speed alone. A new valve run in an engine at low speed showed blue in color when removed. No special steel is required for the valve; cast iron may be used if preferred. The part above the valve is really an extension of the combustion-chamber at one point in the cycle, so that the total amount of dilution with a 7.5 to 1 compression-ratio is just equal to that of a normal engine with a 4.5 to 1 compression-ratio; the flame temperatures are equal although in the first case the compression-ratio is much higher. This is accounted for by Ricardo's statement that a variation of 1 per cent in the weight of the exhaust gas, plus or minus, would raise or lower the flame temperature 45 deg. fahr.

Discussion Brings Out Interesting Data

Replying to a query as to the water-cooling of the head of the cylinder, Mr. Heavenrich stated that there is approximately 5/32 in. of metal around the ports of his engine and that the entire space up to the stem is filled with cooling-water; also that no trouble on account of uneven wear of the valve produced by the wabbling of the stem had been experienced, as had been reported in other engines.

Regarding compensation for wear, if one cylinder should wear more than another, Mr. Bournonville said that wear could not take place and affect one cylinder alone; that as the valve is cylindrical and the casting also cylindrical, if wear were to occur in one place so that the valve did not make contact, greater wear would take place at some other point and the low spot would fill up with carbon until the wear becomes equal again. Rotary valves should not be ground for adjustment; when taken out its surface is like that of a mirror. The machining of the tapered seat is perfectly flat. A difference of expansion, if the cylinder block and head were separate, and a possibility of leakage, Mr. Bournonville said, were obviated by the fact that the cylinder, the head and the valve were all water-cooled; that no leakage of any kind had occurred whether running on six, four or two cylinders.

When questioned as to the actual compression-pressures that were obtained at from 300 to 1000 r. p. m. at a compression-ratio of 8 to 1, Mr. Abell said that at 200 r. p. m. the compression-pressure at a compression-ratio of 10 to 1 averaged about 180 to 185 lb. per sq. in., at 8 to 1, about 150, and at 7 to 1, about 130. Concerning fuel economy at part loads, he said that on a run of 130 miles, with a car weighing 3400 lb., a gear-ratio of 4½ to 1, and the speed sometimes exceeding 70 m. p. h., 20.6 miles were covered per gallon; for ordinary touring the average would be from 20 to 25 miles. The maximum explosion-pressure he had ever obtained he had estimated to be 600 lb. per sq. in.

PRECISION BEARINGS BUFFALO TOPIC

Production of New Type Discussed and Demonstrated at Unusual Meeting

On Oct. 1 a meeting of unusual interest was added to the Buffalo Section schedule. Lees W. Chadwick, of the Chadwick-LeClair Co., presented a paper on The Use of Precision Bearings on Engine Crankshafts. His talk was illustrated by slides and practical demonstrations in which he was assisted by Mark Harris, of the Oakland Motor Car Co.

Mr. Chadwick began with a statement of the modern manufacturing equation:

STANDARDIZED ACCURACY = INTERCHANGEABILITY = UNIFORMITY + ECONOMY.

The interchangeable bearing is produced by a method, later described in full, which makes its adoption commercially possible by reducing the cost of production.

According to Mr. Chadwick, the following qualities are necessary for a perfect bearing:

(1) Be perfectly seated in its support; in this case, the crank or the connecting rod

(2) Have an unbroken surface that gives the oil-film a 100-per cent support

(3) Insure installation with the correct oil clearance 100 per cent of the time

(4) Be constructed of materials that have sufficient strength to withstand the effects of the load for the life of the engine, have satisfactory anti-friction and heat-conducting qualities and have a melting point high enough to resist destruction by heat, yet low enough to act as a safety valve in case of lubrication failure

(5) Its production and installation must be commercially possible

The first three factors, constituting installation or fitting, are, in Mr. Chadwick's opinion, the most important. His experience with high-speed machinery working under unusually severe conditions over a long period of time and the wide variation in the length of life of bearings made of the same materials and running under the same conditions convinced him that fully 60 per cent of bearing failures, excepting lubrication failures, are caused by faulty installation, resulting in insufficient bearing area and incorrect clearances.

As to the fourth factor, bronze is a material that at once suggests itself, as it possesses more of the required qualities than any other metal and permits the easy bonding to it of a metal having the requirements that the bronze itself does not possess, anti-friction and low melting point.

Babbitt the Ideal Lining

Babbitt has proved to be the most suitable metal for the lining, as it possesses the required melting point and anti-friction qualities. Its defects are that it does not have sufficient strength to resist indefinite pounding; it is expensive and will not form a satisfactory union with the bronze without the interposing of another metal between them. Its inability to withstand pounding is offset, first, by using as small an amount as is commercially possible, say from 1/64 to 1/32 in. of lining, which also helps heat-radiation and makes the bearing cheaper, and second, by proper casting methods that densify the structure, thus utilizing its maximum strength.

Mr. Chadwick reported that he had best results from a babbitt formula of 85 per cent tin, 7½ per cent copper and 7½ per cent antimony. As with bronze, the proper handling is more important than exact specifications, providing that impurities are kept out.

The metal for bonding the babbitt to the bronze must, for manufacturing reasons, have a lower melting point than either of the others. Pure tin and various lead-tin alloys are generally used for this, lead-tin being the most popular with bearing manufacturers because it is easier to use, but as the bonding metal determines the ability of the bearing to resist failure due to overheating, it is not so desirable from the engine-builders' viewpoint as pure tin. Pure tin has a melting point of 450 deg. fahr., while the average lead-tin alloy has a melting point of about 360 deg. fahr.

Precision Process Step by Step

The process of producing these precision bearings in itself answers for the fifth factor. As outlined by Mr. Chadwick, it is as follows:

Operation 1—Cast bronze bushings
Operation 2—Bore inside diameter
Operation 3—Tin bronze shell
Operation 4—Turn outside diameter
Operation 5—Babbitt
Operation 6—Bore babbitt
Operation 7—Broach
Operation 8—Grind
Operation 9—Split
Operation 10—Swedge
Operation 11—Finish center line faces
Operations 12 and 13—Drill and cut oil grooves
Operation 14—Burr inside and outside diameters

Every bearing is carefully inspected and all fins and burrs are removed. The result of the finished process is a product that meets all the requirements of a good bearing and then makes it practically impossible for the assembler to get a fit that is not within the prescribed limits, providing, of course, that its related parts, the crank and the crankcase, are also within the required limits. Every bearing so made has maximum contact and correct oil clearance independent of the skill of the workman.

The standard time for assembly of bearings and crankshaft is 3.6 min. In service, it is possible to replace these bearings in a small fraction of the time required to replace and fit the other types, with the assurance, moreover, that the job turned out will be first-class, independent of the skill of the workman. One company has found it possible to cut down the standard time on this operation from 45 to 4 hr.

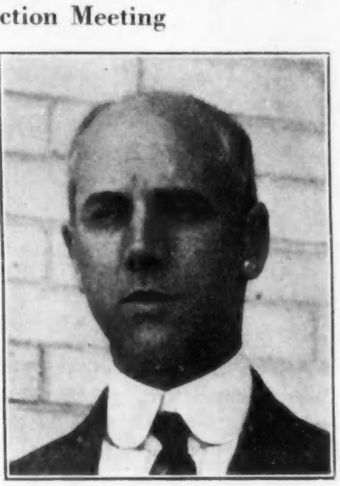
In the discussion that followed, Mr. Chadwick was questioned on the possibilities of babbitting aluminum rods. He answered that it is somewhat more difficult to babbitt aluminum rods, but that it can be done successfully, although aluminum oxidizes more quickly than steel. The tin can, however, be rubbed into the aluminum with a wire brush.

Another point raised was the disadvantages of thick babbitt, aside from its cost. Mr. Chadwick explained that, in the first place, babbitt is only used to act as a safety valve in case of lubrication failure. It is put in so that, if the engine becomes overheated, instead of making a sudden seizure, it will melt and flow. It will pound out because it is soft, and naturally 1/16 in. will pound out twice as much as 1/32 in. Babbitt 1/64 in. thick can be put on satisfactorily. If put on 0.005 in. thick with a paint brush, it would be just as satisfactory.

Asked at what temperature to pour or pump the babbitt, Mr. Chadwick replied that it depended largely on the mixture. The babbitt should be kept just above the segregation point and not as high as the point where oxidization takes place, according to his experience. One cannot, however, go below the point where the metals will not fuse with one another. From 800 to 825 deg. fahr. is a satisfactory temperature, varied according to the size of the bearing and other conditions.

BALLOON TIRES ARE HERE TO STAY

J. E. Hale of Firestone Discusses Their Performance at Indiana Section Meeting


J. E. Hale

A review of the reactions of the considerable proportion of the public that has become accustomed to riding on low-pressure air, and of the car builders that have been experimenting with sample sets of balloon tires, led J. E. Hale, of the Firestone Tire & Rubber Co., to some interesting conclusions on the future of the low-pressure tire at the meeting of the Indiana Section on Oct. 11.

The demand for low-pressure tires has actually existed for a long time. The tire companies' adjustment records show under-inflation to be one of the most flagrant forms of tire abuse. It is a common practice of car-owners to run on low inflation deliberately for the comfort and protection that they can secure. As the indications are that they intend to take matters into their own hands and ride on low pressure with their present equipment, the problem is to produce the true low-pressure tire that the manufacturer can stand back of.

The individual's reaction to the question of the low-pressure tire is somewhat as follows: How does it affect the steering? Does it cut down the fuel consumption? How much do they cost? What air pressure is used? Well, can I buy a set for my car?

When, true to the responsibilities of their positions, car designers proceeded to search for objections, they found that the balloon tires, having some different characteristics from high-pressure pneumatics, could not be substituted without due consideration for these differences. Their attitude toward them ranges all the way from actual adoption by certain companies to direct opposition, with all kinds of opinions between.

Objections Answered

So far as economic reasons unfavorable to air-cushion tires are concerned, the monetary appropriations involved are not excessive, since they are confined to fender changes, details of brake design and axle design to provide additional offset.

As to engineering obstacles, Mr. Hale has not heard of anything insurmountable. There have been cases where the fenders were not wide enough with the new equipment and mud would be spattered, but this is not insurmountable. A few designers have encountered front-wheel shimmy and for that reason have disapproved of this form of equipment. This trouble almost never occurs at speeds below 60 m.p.h. A few cases of front-wheel shimmy on change-over jobs have come to Mr. Hale's attention, but in all these cases the shop mechanics have been able to make some adjustment in the steering mechanism which corrected it. Mr. Hale has found that on his own car he can bring about front-wheel shimmy by slacking off a three-quarter turn on a certain nut in the steering linkage.

The effort required for steering receives very prompt consideration. A soft tire steers a little harder, but steering-gear changes have already been made which give satisfactory results in this case.

Another objection is the belief that the ability to pick-up and to accelerate is slightly affected by low-pressure tires, but as far as Mr. Hale has been able to determine, low-pressure tires affect the engine performance only slightly.

As far as fuel consumption is concerned, there is plenty of evidence that this is not affected adversely. Mr. Hale has himself just completed a 1200-mile vacation trip in a 4-year-old roadster equipped with balloon tires, averaging 17 miles per gal. for the entire trip.

Schedule of Sections Meetings

NOVEMBER

1—Detroit Section—Development of the Commercial Airplane—W. B. Stout.
2—Washington Section—Repainting and Refinishing Automobile Bodies—C. O. Thomae
6—Dayton Section—Better Automobile Headlighting and the Importance of Accurate Equipment and Proper Adjustment—R. N. Falge
New England Section—Brakes—W. S. James
7—Minneapolis Section—Analysis of Various Four-Wheel Brake Designs—C. W. Jacobs
8—Indiana Section—Records of Spring Movement in the Action of Cars—T. J. Litle, Jr.
9—Mid-West Section—The Relation of the Automotive Manufacturer to Motor Transport—David Beecroft
15—Metropolitan Section—Commercial Air Travel—E. P. Warner
Detroit Section—Gears—Is It Necessary to Grind?—Round Table Discussion
19—Cleveland Section—Engineering Aspect of the Used Car—David Beecroft

"Cannonball" Baker Proves Safety of New Tire

Predictions of serious accident have been made if one of these thin-wall tires should blow out on a vehicle at high speed, particularly a front-wheel tire. So far there has been no trouble from this source. "Cannonball" Baker had a front tire go flat while running at 55 m.p.h. and reported that there was no particular difference in the performance of the car between the 7.30 balloon tire and similar occurrences that he had previously had with the regular 33 x 5 high-pressure tires. The only reaction was a slight tendency for the car to draw to the flat side. He also had a tire go flat on a rear wheel when running at 75 m.p.h., but he continued to run at high speed for 15 miles on the flat tire.

Personally, Mr. Hale does not believe that it is possible to adapt the present line of tires and rims to produce a true balloon type by over-sizing and splitting the difference in the number of plies used.

In the judgment of the development department with which Mr. Hale is connected, four sizes of tire are necessary to equip properly the various cars and at the same time follow the pressure recommendations of from 20 to 35 lb. In a general way, the choice of tire sizes to be applied to the various cars is shown in the accompanying table.

BALLOON AND PNEUMATIC TIRE SIZES FOR VARIOUS WHEELBASES

Balloon Tire, Actual Section Size, In.	High-Pressure Pneumatic Equivalent Size, In.	Maximum Load per Wheel, Lb.	Wheelbase Range of Cars for Each Size of Tire, In.
4.40	3½	750	100 to 103
5.25	4	1,000	108 to 115
6.20	4½	1,300	118 to 126
7.30	5	1,700	130 to 140

Shock Absorbers an Essential Addition

In his Summer Meeting paper, Mr. Hale mentioned the desirability of shock absorbers or spring rebound checks and predicted a disappointment with balloon tires without these instruments. At the Indiana Section meeting he emphasized the point even more strongly. The low-pressure tires will take care of the pavement irregularities in splendid shape, but depressions and humps from the general road level seem to produce an excessive rebound and the only apparent remedy is to have rebound checks, but great discrimination must be used in choosing the proper make of check. It is a very complex situation in which the spring characteristics play a very important part. It is an advantage to keep the spring leaves well-oiled.

The tire manufacturers feel that the automobile industry should consider this tire equipment in its hands, and it is for the industry to decide what is to be done with it.

Mr. Hale summarized the situation as he sees it as a result of close association with the public and manufacturers as follows:

(1) Unquestionably the public will ride on low-pressure air
(2) The tire companies must meet the situation by designing and marketing tires that can be used with low-pressure air
(3) The public demand for balloon tires unquestionably will be so great that a large number of existing cars will be changed over
(4) The public will pay more for balloon tire equipment because it looks better, rides better, brakes better, and saves the car
(5) Once the car builders have learned what balloon tires will do for a car, they will be able to design lighter and thereby save money
(6) The January Show will see many cars equipped with balloon tires on the floor.

Moving pictures were shown to demonstrate Mr. Hale's points and discussion followed. Asked about the life of tire rubber and its ability to stand fatigue, Mr. Hale replied that it is his impression that the ability of a good quality rubber to flex repeatedly is so great that it will continue to function in that way as long as the rubber is in good condition. Flexing, however, weakens the cotton.

No Tread Cuts in Balloon Tires

Another question asked how the tire would wear in deep ruts and rough spots. Mr. Hale said that it would not show any tread cuts at all; being soft and not having such intense pressure back of it, it does not fight the road but simply folds itself over. The same thing is true on the side-walls. One can run up against curbs as frequently as may be desired without hurting the tire. One of the big troubles with most tires is the question of tread separation, but Mr. Hale's company has not had a single case of tread separation in balloon tires.

Charles S. Crawford expressed the opinion that, regardless of what the engineer thinks about balloon tires, his opinion will be over-ridden by the general public. It is as well, therefore, to pave the way for the use of them and to do everything possible to benefit the installation. According to Mr. Crawford, the matter of steering resolves itself into making the steering ratio in proportion to the kind of tire used, the load imposed on it and the kind of steering the person wants.

Howard Marmon reported that his experience with balloon tires has been very satisfactory in the riding qualities, but that at present he has not been able to get a satisfactory ratio on the steering mechanism. For ordinary driving, the car steers well but shows a tendency to lean on one side or another.

Charles R. Short emphasized the point that the benefit possible in the use of balloon tires cannot be realized by taking the old chassis with standard springs and standard steering-gear and applying balloon tires. Both the steering-gear and the springs must be modified to benefit from the lower rate of vibration.

The next meeting of the Indiana Section will be addressed by T. J. Lítle, Jr., on Records of Spring Movement in the Action of Cars. The meeting will be held on Nov. 8 in the Severin Hotel, Indianapolis, beginning promptly at 8 o'clock, after an informal dinner at 6:30 p. m.

THE USED CAR AS AN ENGINEER SEES IT

The Cleveland Section will hear David Beecroft, of the Class Journal Co., on the Engineering Aspect of the Used Car at the Nov. 19 meeting at the Cleveland Hotel. Dinner at 6:30 p. m. will be followed by a half-hour's entertainment before the meeting, which will begin promptly at 7:30 p. m.

JOINT MEETING IN DAYTON FOR FALGE

R. N. Falge, of the National Lamp Works, General Electric Co., will speak on Nov. 6 as a specialist on headlighting before a joint meeting of the Dayton Section of the Society and the Dayton Engineers Club. His topic will be Better Automobile Headlighting and the Importance of Accurate Equipment and Proper Adjustment. The meeting, which will be held at the Dayton Engineers Club, will begin promptly at 8 o'clock.

NEW SECTION FORMING IN MILWAUKEE

Stoelting Talks on City Planning and Traffic Control at First Meeting

Members in Milwaukee are holding regular meetings as one of the preliminaries required for the formation of a new Section. At the first of these meetings, on Oct. 24, R. E. Stoelting, Milwaukee Commissioner of Public Works, discussed the transportation problem from the viewpoint of the city, speaking on The Relationship of Automotive Vehicles to City Planning, Traffic Control and Pavements.

Mr. Stoelting emphasized the necessity for careful planning in the future, to avoid jammed traffic streets inadequately

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laid out for their loads. Rapidity, safety and parking facilities are essential factors of the problem to solve which properly it will be necessary to spend as much as the total spent for automobiles to date.

As solutions of the parking bugbear, the speaker suggested municipal garages of immense capacity and small fee and parking facilities for customers' cars on store roofs. He also outlined the need for an arterial highway system with automatic controls at the intersection of highways, more of which are being developed in Milwaukee than anywhere else.

In the future Mr. Stoelting believes that city traffic will be handled by buses, allowing the use of the full street width. In closing, he appealed to engineers for assistance in solving civic problems.

Later meetings will discuss transportation from the point of view of the highway engineer and from various angles in the automotive field. The group meets in the Library Hall on the third floor of the Milwaukee Public Library, Grand Avenue between Eighth and Ninth Streets.

KETTERING SPEAKS AT MID-WEST SECTION

Says Engineer Must Cooperate with Other Departments and Widen Viewpoint

C. F. KETTERING

That one of the grave problems which the engineering fraternity has ahead of it is to settle down and recognize that engineering as an accomplishment is only an accomplishment in so far as it produces a favorable change of figures in the balance sheet and that it is time for the engineers to begin to work out an engineering audit sheet on the work they are doing were the first points stressed by Charles F. Kettering, of the General Motors Research Corporation, in his address to the Mid-West Section at its Oct. 12 meeting.

In developing his argument, Mr. Kettering insisted that one of the biggest problems in front of the engineer today is to acquaint himself more with the economic and business phases of the industry in which he is involved. It is not sufficient for him to lock himself up in his designing department and design something, because he cannot design something apart from his users. He had better spend 50 per cent of his time out in the field with his users and the other 50 per cent in the engineering department designing something, designing improvements, than to spend all of his time in the engineering department, because he must meet the requirement that all engineering is to proportion material in such a way as to render the greatest possible service to his users, no matter what the thing is.

Engineering Closely Related to Cost Department

The engineering department should be adjacent to the cost department. If one has to meet competition and make a 10 per cent reduction in cost, he has some chance of making it if he analyzes the costs of the individual pieces and begins to take the 10 per cent out of each piece. The engineer must take more into consideration than the simple functioning of the article he is designing; he must become the economic control factor. The engineer has never been very much interested in the question of overhead, but he has just as much to do with overhead as anybody else, since it is an engineering problem.

There has been a perfect mania for special machinery during recent years. Mr. Kettering cited figures to show the fallacy of using expensive special machine-tools to perform simple machining operations and said that the question of the kind of machinery needed and the way parts are designed is a very important responsibility. The designer is really responsible, to a certain extent, for the capital investment and for the floor space.

In every big organization there is always a scrap between the engineering department and the production department. There is one best way of settling that, and that is to have the better educated fellow give in. Swallow our pride and get the result regardless of whether we get credit for it or not. Our job as research engineers is not to look upon the automobile as a finished commercial product today but to look at it to try and find out what is wrong with it. Research is simply a state of mind and the way we get that state of mind is to be dissatisfied with something we have got or something we are doing. To put it in another way, research is the correction of a fault.

Expanding Viewpoint Essential to Progress

The average engineer never realizes that he is getting older every year. He graduated from school when he was 22 years old and could see things. He gets older, and along about 35 or 40, he passes the center of population; in other words, there are just as many on this side of him as there are on that side of him. As he gets a little older, he sees things in terms of what he used to be and he is in a foreign country, so far as his notions are concerned. If he does not get back and get the new point of view, he is lost. Whenever one feels that he is getting his job licked into good shape, it is an indication that he has had the shutters closed on his windows and must get out and get another viewpoint. Mr. Kettering believes that an engineer ought never look for the rock bottom end of anything. There may be a limit to the thing as he sees it today, but with new things coming in all the way along the line, the ultimate cannot be prophesied.

Mr. Kettering illustrated how radical changes in viewpoint have been responsible for revolutionary changes in the painting of motor cars. He cited another case in which persistent study, unhampered by satisfaction with initial progress, resulted in lengthening the life of fan-belts 70 times that expected before research was undertaken. He also presented many interesting comments on the progress of scientific research in other fields such as chemistry, physics and medicine and pointed out the fundamental relationships between them.

American industry today with the research laboratories that are being established, with its more open-minded attitude and with a closer association of the engineers to the business management gives every opportunity in the world for a marvelous advancement.

A big motor transport meeting is planned as the November number on the Mid-West Section's program. Fleet owners and service-men are especially invited to hear David Beecroft, of the Class Journal Co., on The Relation of the Automotive Manufacturer to Motor Transport at the meeting on Nov. 9 in the Western Society of Engineers' rooms, Monadnock Block, Chicago. The meeting will begin at 8 p. m. after an informal supper at 6:30.

MANUFACTURE AND USES OF DURALUMIN

Alloy Developed for Aircraft Purposes Finds Many Automotive Applications

Duralumin and its applications was the subject discussed at the meeting of the New England Section of the Society held at the Highland Hotel, Springfield, Mass., on Oct. 23. Following the customary dinner, R. E. Northway, chairman of the Section, introduced R. W. Daniels, sales engineer of the Baush Machine Tool Co., who presented an exceedingly instructive paper on the recent developments in the use of this aluminum alloy that was brought to its present state during the war and has played such an important part in the construction of both airships and airplanes.

In the afternoon preceding the meeting a visit was made

to the plant of the Baush company, where under the guidance of Mr. Daniels, H. O. Shepard, works manager, and C. H. Calkins, manager of the machine tool department, about 20 members of the Section took advantage of an opportunity to follow the course of manufacture from the pouring of the metal to its finished state.

Mr. Daniels said in part that, invented in Germany by A. Wilm and associates about 1903, duralumin was first manufactured by the Durener Metallwerke, Duren. Vickers, Ltd., next took up the metal, making it in England and granting a license for its production in France. Soon after the close of the war its manufacture was undertaken in this Country and it is today readily procurable in all forms and of a quality equal to the best foreign product.

Duralumin is an aluminum alloy that, when wrought and heat-treated, combines to a remarkable degree the lightness of aluminum with the strength and toughness of the ferrous metals. When subjected to ultimate stress, it is, at its best, the equal of good open-hearth steel that is stressed to the same percentage of its tensile-strength. It is recognized as occupying the same relative position to ordinary wrought aluminum that heat-treated alloy-steel does to ordinary mild steel. The principal and unusual feature of the alloy is that after it has been hot or hot-and-cold worked it may be further strengthened and toughened from 40 to 50 per cent by a heat-treatment that is analogous to the heat-treating of alloy-steels and consists of quenching from temperatures below the melting point followed by an aging process in which the alloy is maintained at a minimum temperature of 70 deg. fahr. Its maximum qualities are not reached until a period of at least 48 hr. has elapsed. Higher temperatures shorten the aging period but do not commercially affect the results.

In composition, the principal constituents of duralumin are aluminum, plus its usual impurities of silicon and iron; copper, 3 to 5 per cent; magnesium, 0.20 to 0.75 per cent; and manganese, 0.4 to 1.0 per cent. Small quantities of other metals such as chromium are sometimes added for specific reasons. The melting point is approximately 1200 deg. fahr., the annealing temperature preferably 680 to 700 deg. fahr., and the heat-treatment range 910 to 970 deg. fahr.; the coefficient of expansion is 0.0000123 in. per degree of temperature. When heat-treated its strength is comparable with mild steel, section for section, while its specific gravity is 2.81 compared with 7.80 for steel.

When used in the proper condition, duralumin lends itself admirably to the ordinary methods of manufacture; it may be both hot and cold-rolled, extruded, forged under the press or the hammer, or in the bolt machine; it may be drawn, spun and handled in the crank or toggle press similarly to soft steel; it may be machined readily and when so used cuts with a clean chip, without tearing or dragging, at a considerable saving of time over that of steel and most other metals. It is non-magnetic, non-corrosive, highly resistant to atmospheric influences and to the action of both fresh and salt water, is only slightly affected by the chemicals that attack most metals and does not tarnish in the presence of sulphuretted hydrogen. In appearance it closely resembles silver, takes a polish equal to nickel plating, remains bright without cleaning longer than any plated or silvered article and is not stained by handling.

Tests of the ultimate tensile-strength of the heat-treated material vary with the dimensions of the test-piece, showing a minimum of 55,000 lb. per sq. in. for bars less than 1 in. in diameter, or width across the flats, and a minimum of 45,000 lb. per sq. in. for bars over 2 in. in diameter, or in width across the flats. The corresponding yield-points are 25,000 and 20,000 lb. per sq. in. while the elongation is between 17 and 18 per cent in 2 in. Annealed material has a tensile-strength of from 25,000 to 35,000 lb. per sq. in.

Four years of experience with duralumin at the plant have proved that failures are due to incorrect design, faulty workmanship or defective material and not to any change in the physical properties of the alloy. Defects caused by foreign matter, air bubbles and the like, are similar to those produced in steel.

The steps in the manufacture of duralumin are similar to those of steel and are (*a*) the manufacture of the alloy from its aluminum base; (*b*) casting the ingot; (*c*) hot rolling or cogging the ingot into blooms, billets or plates; (*d*) hot or cold-working into the final shape; (*e*) heat-treating or annealing; and (*f*) further cold-working under certain conditions only.

During these various processes the physical properties are increased by distinct steps and the ultimate tensile-strength may be increased from 6000 to 10,000 lb. per sq. in. by cold-working after heat-treating and aging. Annealed duralumin may be heat-treated and, conversely, heat-treated duralumin may be annealed. When annealed it can be drawn, spun, stamped and formed into a great variety of shapes, similarly to brass and mild steel; when heat-treated it combines a remarkable tensile-strength with the ability to be formed; when heat-treated and hard rolled it is used where no bending or forming is required.

Among the uses to which duralumin has been put are the structural parts and the wing and fuselage covering of airplanes, main-bearing bearing-caps, pump driving parts, and propeller flanges. The successful flights of the Shenandoah have been a notable achievement, and the fact that the winning airplanes in the recent speed contests at St. Louis were equipped with duralumin propellers is not generally known.

In automotive work its use is extended to such inertia parts as connecting-rods and to unsprung parts such as disc wheels and the hub caps of wire wheels. Its pleasing appearance when polished and its ability to withstand handling and exposure have increased the demand for it for such parts as hood catches, door handles, latches, and lamps.

Following the reading of the paper a lively discussion brought out many additional details concerning the various applications of the metal to automotive practice.

Mr. Daniels' replies to the questions asked may be summarized briefly as follows: Standard tests are necessary to determine crystallization from which, however, duralumin is remarkably free; that no trouble has been experienced with duralumin connecting-rods; that less time is consumed in machining when the work is stationary; babbitting imposes no difficulty, the melting point of tin being just under that at which duralumin begins to soften; no special preparation is necessary for tinning, as molten tin removes the oxide from forged duralumin as well as applies the tin; when babbitt is cast no reaming is necessary; duralumin can be die cast but is usually looked on as a metal that has to be wrought; successful die-casting depends largely on the manner of doing the casting; brake hangers are cast directly on the shaft; duralumin can be welded as well as aluminum; its conductivity is about 40 per cent of that of pure copper; in transmission spans the use of longer spans might prove economical; in rolling the strains imposed by heat-treatment are neutralized; duralumin may be used as a bearing metal with case-hardened steel and duralumin connecting-rods are used with steel crankpins; regarding the holding of heat before annealing, care must be taken that the heat goes entirely through the part; no advantage is to be gained in holding the temperature before quenching; if allowed to drop in temperature with that of the furnace the material will be more ductile; no color scheme has been worked out to indicate the kind of metal, but all shipments are marked; the Brinell test is the easiest method of determining the kind of metal; the fracture after the tensile test is fibrous, a round section showing a crystalline structure, a square section having the fracture on a slant; an unusual shape would indicate the presence of foreign matter; in general, the defects are similar to those to be found in steel; laminations are caused by air bubbles in pouring; it is not possible to tell with a microscope whether duralumin has been heat-treated.

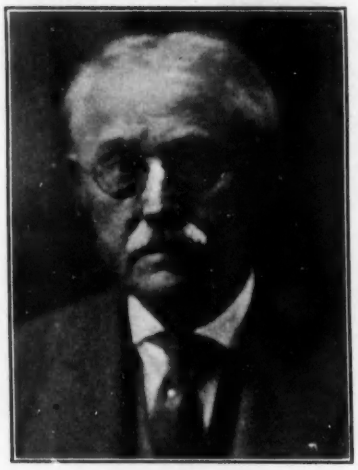
Continuing further, he said that little trouble had been experienced on sea voyages but that salt water does affect the metal slightly, especially if it were to get between layers; although duralumin can be furnished in lengths suitable for the panels of automobile bodies, it is not much used for this purpose, as aluminum panels are good enough; no special

effort has been made to use duralumin as a bushing, but it would run cool and wear well with steel and alloys if sufficiently well lubricated; it is satisfactory as a bearing metal only when used with hard steel; a piston of cast duralumin would give the advantages to be obtained from light reciprocating parts, less vibration and better lubrication; the parts may be made smaller but if made the same size their life would be lengthened; pistons and rods frequently do not balance; either a light piston is used with a heavy rod or vice versa; it is of no advantage to balance a crankshaft and pay no attention to what is put on it; in price, duralumin cannot be compared with steel as the cost is from three to four times as great; it would compare very favorably with bronze; brass castings are today competing with bronze castings owing to the fact that with bronze the roughness is always at the fillets while with brass it usually is at the end.

The next meeting of the New England Section will be held at the Engineers' Club, Boston, on Nov. 6. Dinner will be served at 6:30 p. m. and the meeting will begin promptly at 8 o'clock. W. S. James, physicist of the Bureau of Standards, will discuss Automobile Brakes, with particular reference to those of the four-wheel type.

LOW-PRESSURE CORD TIRE PROBLEMS

J. F. Palmer Tells Buffalo Section That Cords Must Be Wound by Tangent Method



J. F. PALMER

Many of the engineering obstacles in the path of development of the low-pressure cord tire can be overcome by laying the cords on the carcass so that they are tangent to the base or rim circle of the tire. This is the opinion of J. F. Palmer, of the Dunlop Tire & Rubber Co., who addressed the Buffalo Section, Oct. 29, on the Problems of Low-Pressure Tires. Some of Mr. Palmer's comments are given in the following paragraphs.

Power efficiency and safety must not be sacrificed to mere ease in riding. Cords and rubber as used in pneumatic tires offer little resistance to distortion in the absence of air pressure, hence in reducing the air pressure below current practice it must follow that the stabilizing element is proportionately reduced in efficiency. Brief consideration of the conventional cord-tire structure exposes the engineering error of connecting the rim, which is the last rigid point in the power-transmitting line, with the road surface by tension members lying on a double curve. Until the tension in the cord structure is equal to the force acting upon it, it does not respond with useful work. This wasted effort causes nothing but frictional heat that, under extreme conditions, burns up a tube in a short time. This is exemplified in high-speed bus duty and constitutes one of the present problems in that service.

The problem to state it in few words, is to secure low air-pressure without doing it at the expense of cord tension, efficiency and safety. Tangent winding appears to offer a solution. In this scheme the path taken by the cords is tangent to the rim base, or rather to circles falling within the flange and extending from tread point to tread point, each course of these cords being slightly inclined to its predecessor. This construction builds up the beads by the over-lapping plies of cords and renders unnecessary any other provision for attaching the tire to the rim. It is apparent that under the air pressure this type of tire has no tendency to lift from the rim, but, on the contrary, will hug it. Each cord pulls progressively from tread point to tread point all the way around the tire, the rim base and the flanges serving only to give frictional contact for power transmission and any other duty imposed in use.

The tangent cord line coincides with the power line, viewed in side elevation and affords the longest possible length of cord from edge to edge of the casing on rims of any base diameter. For this reason, the air pressure can be proportionately less to maintain equal cord tension in the carcass members. Power losses in transmission are minimized because the long flat arc described by the cords creates a longitudinal base of the tire that is unequalled in any other construction.

Rim widths should be standardized. There is a proper width of rim for each size of tire and, for the best results, no other size should be used. This is of increasing importance as tires of larger sizes are used. Hence the term oversize as used today in relation to tires has, properly speaking, no relation to the duty or capacity of the tire but refers solely to the width of rim upon which it is used. The matter of cost has apparently been the determining factor in original rim equipment, leaving to the purchaser the decision as to whether tires adequate for the duty required of them are supplied. If he decides that the engineers responsible for the job did not know their business, or knowing it failed in their duty, he buys oversize tires and puts them on the old rims. Tire manufacturers, willing to make anything in demand have created so-called oversize tires. Now we are confronted with double and even triple oversize tires, in an effort to graft the new idea of adequate cushioning upon the original inadequate rim.

MINNEAPOLIS TO STUDY BRAKE DESIGN

The Minneapolis Section met on Oct. 3 to plan for the development of the Section and arrange a program for the coming year. Appointments made by the Minneapolis Governing Board as follows went into effect at this meeting. A. F. Moyer, formerly vice-chairman, succeeds Victor Gauvreau as chairman, as Mr. Gauvreau resigned his office on leaving Minneapolis. C. T. Stevens and A. H. Bates will head the Membership and Program Committees.

The first meeting scheduled will be held on Nov. 7 at the Manufacturers Club, Builders Exchange, Minneapolis, beginning at 8 o'clock. C. W. Jacobs, service-manager of the Pence Automobile Co., will talk on the Analysis of Four-Wheel Brake Designs. He will discuss in detail the present systems of four-wheel brake layout, external contracting, internal expanding, "booster," equalized, non-equalized and differential. Types of brake-shoes and bands and methods of applying braking power will also be considered.

PAINT MEETING IN WASHINGTON

C. O. Thomae, technical expert with Valentine & Co., will talk to the Washington Section at its Nov. 2 meeting in the Cosmos Club on Repainting and Refinishing of Automobile Bodies. Mr. Thomae's long experience as a paint expert makes a valuable and interesting meeting certain.

THE AUTOMOTIVE PRODUCTION MEETING

Over 400 in Attendance at Second National Production Gathering in Cleveland

Although the attendance was not as large as that at the Detroit Production Meeting of the Society, the meeting in Cleveland on Oct. 25 and 26 lacked none of the interest or enthusiasm of the former occasion. Men were in attendance from all sections of the Country and most of the principal automobile companies were represented. The registration reached a total just in excess of 400 persons and each of the sessions was attended by upward of 200 production men. Over 250 members and their guests were seated at the Production Dinner on Friday evening where they enjoyed a

K. L. Herrmann John Younger
CHAIRMEN AT TWO OF THE SESSIONS

highly inspiring address by R. H. Grant, general manager of the Delco Light Co.

Most of the Production Meeting papers are printed in this issue of THE JOURNAL, but the following paragraphs report in abstract form the information that was brought out in the discussion following each of the presentations. Great interest was manifested in the paper on the wage-payment methods practised in the Chandler plant as will be noted by the number of points raised in the discussion. Questions and answers that followed the papers on grinding indicated a general tendency in the industry toward higher standards of dimensional precision and surface finish. No doubt this raising of manufacturing standards accounts for the reported increased durability and life of the modern motor car.

Many of the men in attendance at the meeting suggested the possibility of holding an exhibition of new machine tools in conjunction with future Production Meetings of the Society. It was thought that this plan would enable factory executives to inspect the latest developments in tools and methods at one time and place, thus conserving their time and increasing the service of the meeting to both the builder and the buyer of machine tools. A canvass will be made of the machine-tool industry to determine whether it will support such an exhibition as being of service to it. If the reaction is favorable, it is probable that the next National Automotive Production Meeting will be a doubly attractive one and will draw one of the largest attendances in the history of the Society. A distinct effort will be made through the coming year to interest the experts in production matters at the car and parts factories in presenting papers at the 1924 Production Meeting. It was the opinion of many in attendance at the Cleveland meeting that a large number of papers from such individuals is essential to the full success of the production activities of the Society.

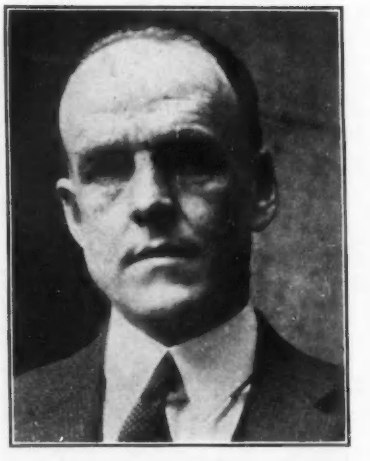
MULTIPLE-SPINDLE MACHINE TOOLS

E. P. Blanchard Describes New Continuous-Type Machine at Production Meeting

Multiple-spindle machine tools and their advantages were discussed in the first paper read at the Cleveland Production Meeting. This paper was written and presented by E. P. Blanchard, of the Bullard Machine Tool Co. He analyzed machining methods as an introduction to the description of the particular machine-tools built by the company he represents. Mr. Blanchard said that it is obvious that the operations necessary to produce a finished piece may require a variety of speeds. Also, the conditions of work for each operation may be entirely different. The single-spindle simple-tooled unit accomplishes this by a readjustment of all cutters and settings on each operation and by stringing one operation after another. While cutting efficiency is obtained by this process, the time of accomplishment is prolonged.

Loss of time between the operations is eliminated by using the turret tooling method in combination with side-heads or cross-slide arrangements, but the sequence still exists. Multiple-tooling, or a grouping of all of the tools about the work for simultaneous cutting, has been tried to eliminate the sequence, but it has resulted in compromising the machining factors of speed and feed and thus destroyed the cutting efficiency. Complicated tool settings, inaccessibility of the tools for adjustment and difficulty in chucking the work are further disadvantages of the multiple-tooling method, according to Mr. Blanchard. In all the foregoing methods there still exists the inevitable delay of interrupting the machining process for chucking and unloading the work.

It follows from the above line of reasoning that the multiple-spindle principle is the logical one for continuous production. This principle is represented in what is known as the station type of machine tool. In this machine, the piece is the unit of production and the operations to be performed are segregated into groups requiring similar machining factors of speed, feed and tooling. With entirely independent and universal settings of speeds, feeds and tools at each station, the finished piece can be produced under conditions of highest efficiency by setting all tools required for a single cut, or a group of cuts having similar machining factors, at the separate stations of the machine. In this case, the chucking and the unloading is accomplished at one station while the machining operations are in process at the five working stations.



E. P. BLANCHARD

Another type of machine recently developed by Mr. Blanchard's company employs what may be termed the continuous multiple-spindle process. In this type of machine the operation or the group of operations performed at each chucking is the unit of production, and all operations are accomplished in one complete cycle of the machine. Each work-holding spindle is always opposite its respective tool-head, and all work-spindles and heads are in continuous rotation about a central column. The work is chucked as the spindle passes through the loading sector and while machining is in process through the remainder of the cycle. Mr. Blanchard showed several typical examples of work to which this process of machining can be adapted and gave the time required to complete the operations in each case.

Eccentricity and lateral run-out can be held within limits of 0.00025 in. on the machines described by Mr. Blanchard. He stated in reply to a question that it took demonstrators only 1 day to educate operators on the proper handling of these machines. It was his opinion that the continuous multiple-spindle machine could be installed profitably if it were operated only 2 months in the year. Some firms have found it economical on runs as short as 300 to 400 pieces. The continuous-type machine is especially adapted to the larger pieces of work, say 10 to 18 in. in diameter, and is often used for machining flywheels.

SPUR-GEAR GRINDING AND TESTING

Paper of A. J. Ott Discusses New Machine for Generating Accurate Teeth

Spur-gear grinding and testing was the subject of an interesting and informative paper that was presented by A. J. Ott at the Thursday morning session of the Production Meeting. A generating type of gear-grinding machine was described and a fixture for testing spur gears was displayed

and demonstrated. The paper by Mr. Ott and his son, C. L. Ott, is printed in full on p. 401 of this issue of THE JOURNAL.

Numerous questions were asked the author during the discussion period and the answers to some of these are of interest. He stated that from 0.003 to 0.005 in. is removed at the pitch line of the teeth by the grinding operation. The grinding time required on the average transmission gear is from 5 to 6 sec. per tooth. Using a grinding wheel 30 in. in diameter permits the machine to grind gears up to a face width of 2 in. Both the driving and the coasting faces of a spur gear having 33 teeth can be ground at the rate of 55 to 60 gears per day. With ordinary care grinding 60 teeth without dressing the grinding wheel should be possible. The wheel should not be dressed while a gear is being ground.

From 0.005 to 0.010 in. backlash is all that is necessary in the opinion of the authors. An accuracy of tooth profile within limits of 0.00025 in. can be attained with the gear-grinding method. A labor cost of 50 cents will be added to the total cost of an average passenger-car transmission if all the important gears are ground. Gear grinding not only accomplishes a reduction in the gear noise of automobile transmissions, but it saves tear-downs after assembly and tends to increase the durability of the gears because of their smoother running. Teeth having contours of a modified involute form can be ground just as readily as those following the accurately developed involute.

W. Hadley, the English representative of an American gear-grinding machine builder, stated that grinding of transmission gears was fairly universal practice in England.

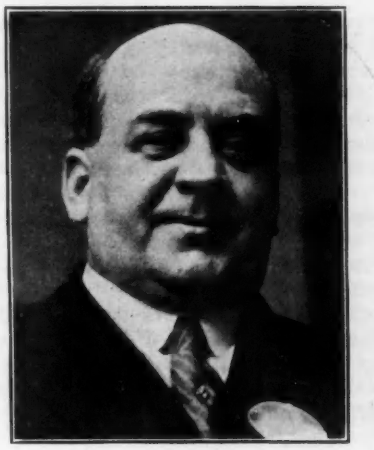
A. J. AND C. L. OTT

European motorists shift gears frequently and they insist upon reasonably quiet operation of the first and second gears. Some British companies run-in gears with lapping compounds, but the great majority are now employing the machine-ground gear as a means of reducing the transmission noise.

PRODUCTION GRINDING DEVELOPMENTS

Production Meeting Paper and Discussion Reveal Demand for Mirror-Like Finish

Recent developments in production grinding were described and illustrated in the last paper in the Thursday morning session of the Production Meeting. This paper was prepared and read by Oscar A. Knight, of the Norton Co. It will be found printed in full on p. 387 of this issue of THE JOURNAL.



O. A. KNIGHT

Following the reading of the paper, Mr. Knight answered numerous questions put by members of the audience and the following paragraphs summarize his answers and the general discussion. Increasing the diameter of crankshafts does not permit the removal of steady-rests in crankpin grinding-machines, in Mr. Knight's opinion. In some instances these heavier shafts, although more rigid, tend to vibrate during the grinding operation and this will be eliminated if the work is properly backed up by a steady-rest. The balancing of grinding wheels is receiving constant study and no balancing devices will probably be needed on the grinding machines of the future because the wheels will be made so as to remain true throughout their life.

The limits for alignment of the pin-axis and shaft-axis should not be greater than 0.002 in. or they will retard production, according to Mr. Knight. Mention was made of one firm that buffs all crankpins after grinding, the buffing being done in the opposite direction of rotation from that followed by the crankshaft in its bearings. This is done on the theory that the buffing operation removes small metallic particles and smoothes the surface down so that irregularities in the pin surface will present smooth edges to the babbitt bearing and eliminate any tendency to pile-up and score it. Buffing, if correctly performed, improves the surface of the average shaft after it has been finish-ground. It will not correct out-of-roundness of the ground shaft, however, but will follow the basic surface that has been formed in the grinding machine. Grain lines can be eliminated if the grinding wheel is arranged to oscillate a slight amount; this oscillation need not be more than ⅛ in.

A tendency toward a greater application of the centerless method of grinding exists, in Mr. Knight's opinion. Just as great accuracy can be secured from the centerless machine provided great care is taken in its use, however the full production advantage of centerless grinding will only be secured if the limits are fairly wide. Asked whether he favored the use of ball or roller bearings to support the main spindles of grinding machines, the speaker replied strongly in the negative. Chatter and mottle marks nearly always become more pronounced in work that is done on grinding machines that use ball or roller bearings in this place. Chatter marks were reduced by substituting a chain for a gear drive in the machines described by the author, who stated that inaccuracies in the gears were responsible for the chatter and intimated that gears might be satisfactory if accurately made.

Wide-wheel grinding is limited at present to a maximum of 9¾ in. and Mr. Knight was asked the reason for this limitation. He replied that it is entirely a matter of properly supporting the grinding wheel. Placing a bearing on the outside or the inside of a wide wheel is not good practice because it would be necessary to remove the bearing to change the wheel and this would affect the alignment eventually.

Arthur C. Pletz, of the Morris Machine Tool Co., Cincinnati, described a method of buffing crankpins with a machine very much like a grinding machine. This machine uses a rotating hard-felt wheel instead of the grinding wheel. This wheel is covered with an abrasive preparation and is kept in contact with the rotating crankpins for only a few seconds. It is used to get a mirror-like finish on the surface of the crankpins after they are ground and is not intended to correct any errors in the contour of the ground shaft. Less

than 0.0001 in. of metal is removed by this buffing operation.

The need for a standard method of classifying and identifying various degrees of surface smoothness or polish was shown by the discussion. Mr. Knight said that motor-car factories are demanding a higher grade of surface finish on ground parts than ever before. The highly reflective surfaces that are being demanded take longer to produce, but the grinding-machine builders are striving to construct machines that will produce these finishes in the same time as the so-called commercial finish.

Experiments have been made on wheel-oscillating attachments for cam grinding and it was Mr. Knight's hope that these would produce satisfactory attachments for general use on camshaft work. These experiments will also lead to the perfection of automatic machines for shoulder grinding.

LABOR PSYCHOLOGY AND PHILOSOPHY

Interesting Views Expressed in Production Meeting Paper Read by W. F. Jameson

All factory executives are familiar with the time-worn expression "human element errors." The psychological causes for the worker's state of mind that results in the making of careless errors have been studied by W. F. Jameson, chief inspector of the Cleveland Automobile Co., and were the subject of his paper that opened the Thursday afternoon session at the Production Meeting in Cleveland. Mr. Jameson's paper will be found printed in full in this issue of THE JOURNAL on p. 366.

W. F. JAMESON

President Alden, who presided at this session, opened the discussion by telling the experience of one steel manufacturer who believed that the inauguration of the 8-hr. day and the consequent studying of means to improve the welfare of the steel-worker would result eventually in lowered rather than raised production costs in the steel mills. Mr. Jameson was asked how he rewarded the conscientious worker who showed evidence of concentrating and thinking on his job. He replied that the worker must be sold on the fact that his own satisfaction with his work is his reward. Of course, this thought cannot be sold to all workers; they must be possessed of some intelligence to grasp the significance of it.

Good salesmanship is essential to the successful introduction of Mr. Jameson's plan of worker-interest stimulation. His experience has been that the men in the shop can be interested in the idea that their job is their school, but good selling methods are required to convince them. Once the employe has grasped the idea, its fruitfulness depends upon the caliber of the man himself. To make a start in a given plant, the best way is to select a few men whose reflection of common sense indicates that the chances of successful application in their cases is at least an even one.

FRANKLIN CONVEYOR EXPERIENCE

H. P. Harrison Unselfishly Describes Unsuccessful and Successful Installations

Material-handling continues to be an important phase of manufacturing efficiency. This was evident at the Production Meeting as one observed the attentiveness of the audience that listened to the paper read by H. P. Harrison, of the H. H. Franklin Mfg. Co., on the application of conveyor equipment in the factory of that company. The conditions that determine whether power-driven or gravity-actuated conveyors should be used were discussed. Mr. Harrison illustrated his paper fully and showed types of conveyor equipment used for handling cylinders, transmission cases, rear-axle housings, front and rear-axle assemblies and for the final assembly of complete chassis and bodies. His very interesting paper will be found, printed in full, on p. 357 of this issue of THE JOURNAL.

H. P. HARRISON

Reference to Mr. Harrison's paper will show that he did not explain how the cylinder carriers were returned to be used again. This point was covered in his answer to one of the questions presented in the discussion. He said that the carriers are returned on the downward travel of the outside elevator chain, fed back into the line at a point below the delivery section of the gravity chute, then picked off automatically at the basement level and dropped in a pile at that point. About $125 has been saved daily by the installation of conveyor equipment in the Franklin plant. All the assembly conveyors are in motion when assembling operations are being performed. They are driven by adjustable-speed motors that can be set for any desired daily production.

Franklin cylinder castings come to the conveyor from the foundry in fully sand-blasted condition. They are cleaned at the end of the machining line in an atomized-steam kettle. This operation supplies enough heat to the casting so that it dries itself and is then given a coat of paint. No auxiliary method of moving parts in case of conveyor breakdowns is provided in the Franklin installation. Parts are trucked in an emergency of this sort. No serious delays have been experienced from conveyor failures and it is possible to make minor repairs and carry on conveyor maintenance-work at night, since the Franklin shop operates on the 8-hr. day.

GROUP PIECE-WORK WAGE PAYMENT

System in Use at Chandler Plant Is Described in Paper at Production Meeting

Production engineering divides itself into three general classifications, material, labor and tools. To say that some of the most perplexing manufacturing problems are those connected with the labor classification is not exaggeration. For this reason labor control and wage-payment systems have a place on any program of production papers that claims to be at all comprehensive. In the case of the Cleveland Production Meeting it was noticed that more questions were asked about Eugene Bouton's paper on Wage-Incentive Systems than possibly any other topic on the program. This paper sets forth a system of individual and group piece-work wage payment that is in successful use at the plant of the Chandler Motor Car Co. It will be found printed in full on p. 380 of this issue of THE JOURNAL. Some of

EUGENE BOUTON

the important questions and answers raised at the meeting are reported in the following paragraphs.

Labor turnover has been materially reduced by the adoption of the wage plan described by Mr. Bouton. It has stimulated collective effort, the men try to help one another and attendance records are much improved. All employes receive an hourly rate and after the group price is set they are pro-rated on that hourly basis. If a man's hourly rate is raised, the cost is not increased, but he gets a higher pro-rated share of the group's earnings. If certain members of the group apply themselves more conscientiously than others, they should be rewarded for their effort. Slow and lazy workers are frequently run out of a group by the other workers in it, but there is seldom any trouble between the men when all are industrious.

Daily earnings of the men in each group are reported to them by their foreman. He receives a copy of the group piece-work report and can give the workmen the information from that. After the group has been in operation for some time the men are able to gage their earnings readily without making inquiry of the foreman. Two days are allowed for a new employe to accustom himself to the work in the group to which he is assigned. If he is unable to come up to the required speed, he is taken out of that group. Determination of the rating of the men in a group is left in the hands of the foreman. Time studies assist him in making this determination but he must use considerable judgment also.

Mr. Bouton was asked what he considered a fair percentage to add to actual time studies as an allowance for fatigue and contingencies. He replied that this would vary between 10 and 20 per cent, depending on the particular job. Machine-tool builders make a practice of allowing 20 per cent. Piece rates are not cut in the event that they are set too high. The only reason for cutting rates would be a change in tooling or a change from one type of machine to a more efficient one. If the worker makes more than it was intended he should make, the condition is simply put up with. Fair wages for a given locality must be determined by the management of the company and the base rates set from that by the planning department.

Allowance for scrap is largely dependent upon the nature of each job. Where tolerances demand a high degree of accuracy, an allowance of 2 per cent might be necessary. When the scrap deduction is made from the group, only the labor and the time expended on the work is considered; no deductions are made for material scrapped. The system described by Mr. Bouton guarantees the workman a minimum hourly rate, but if the worker is unable to exceed this he is not an economical producer. He should earn the base rate or turn out the number of pieces specified on the route sheet before he is considered efficient.

In the 6 months' application of the Chandler system it has been noticed that inspection expense has decreased because payments are made only on the accepted pieces. If any deductions are made, the men realize that the loss applies to the entire group and they soon aid one another in reducing the number of rejected pieces. Mr. Bouton believes that any group system of wage payment effects a reduction in inspection expense. He allows only 1 per cent for scrap on the average.

When one member of a group receives an increase in his daily rate, the earnings of the other members of the group are slightly reduced. This has never caused any trouble within the group, according to Mr. Bouton. If a member of the group is tardy 1 hr., he loses that proportion of his pro-rated earnings and this amount is credited to the remainder of the workers in the group. So-called speed-experts or pace-makers are never injected into groups to speed them up. Sometimes the efficiency fostered by the group plan leads to the men earning much more than was anticipated, but that is a contingency that must be accepted with any group plan.

Inspection work in the Chandler plant is done on a straight-day-work basis. This is also true of the tool department.

No provision is made under the group piece-work plan for men who may be absent. If a group consists of 10 men and 1 man is away, the work is turned out by the remaining 9 men and all the earnings divided among them. If the men in a group are dissatisfied with a new man, they appeal to their foreman who replaces this man with another who is acceptable to the group. In this way the men may be said to have a voice in the selection of the workers making up their respective groups. Mr. Bouton does not find that individual incentive is lacking in large groups, say of 90 men. They are all anxious to help one another and whenever congestion at any point occurs the men assist the worker who is behind, without receiving any order from the foreman. The hourly rates guaranteed under the plan described are lower than those paid for straight day-work.

J. C. W. Smith, of the Willys-Overland Co., said that his company had applied the group system, but paid all men in the group the same wages. He favored piece-work wage payment instead of the standard-time system because the worker could figure out his own earnings more readily and this avoided misunderstanding. He referred to the paper given by E. K. Wennerlund[2] at the Detroit Production Meeting and said that he considered it had one fault. This is illustrated by the case of two men, both grinding axle-shafts, who receive different amounts of money at the end of a pay period although both produced the same number of pieces. If the supply of labor in the market is ample, under the day-work system men can be hired at the lower rate on axle grinding and the man on the higher rate let go. The Overland factory makes a practice of guaranteeing piece-work prices for a year and standing by them even when errors are made in the original setting. This policy has resulted in at least a 25-per cent increase in the labor efficiency in the Overland plant.

Mr. Bouton agreed with the criticism of the group-bonus plan. He said that there is no reason why one man should draw more money than another just because they are on the same job. The piece-work plan is superior for group incentive because it assures a reward to each man in a measure proportionate to his efforts.

FUNCTIONALIZED TIME-STUDY METHODS

Production Control System of the Corona Typewriter Co. Explained in Detail

PERCY S. BROWN

At the Scientific Management Session on Thursday evening, Percy S. Brown, works manager of the Corona Typewriter Co., presented a comprehensive statement of the production control methods of that company. The paper was, of course, specific and obviously the preparation of it had required a great amount of work. President Feiss, of the Taylor Society, who was present at the meeting, referred to the fact that F. W. Taylor always refused to speak less than 2 hr. on the subject of management and maintained that the only way to present any matter of real importance connected with the subject is by submitting concrete examples.

It was clear from the evidence, Mr. Brown submitted that the business of his company is well organized and controlled. It is helpful to have designers of automotive apparatus consider what is necessary in the analysis and the design of a business. The principal factor in the lowering of the price of a final product is the reducing of the cost of the operations involved in its fabrication. Of course, wide distribution is essential to the carrying out of the

[2] See THE JOURNAL, November, 1922, p. 402.

policy of repeatedly lowering the price of finished products. Mr. Brown made the general statement that continuous-process manufacture, like that of a large automobile factory, makes possible the elimination of the recording of many details, the conveyor being of great assistance in this connection. At the Corona factory, operations, such as inspections, which are on piece-work are not time-studied. The wage system has the following bases; straight-piece, straight-wage, and straight-salary with no bonus. Fifty per cent of the operations at the Corona plant are inspections. Aside from these, 90 per cent of all the operations that can be carried out as piece-work are done according to that method.

Introduction of System

The functional system of factory management was introduced at the Corona plant in 1917, the change from the so-called military type of organization being made instantly. The principal thing in the conduct of a factory being co-operation, no new system, however efficient, can be reduced to practice in a short time without the personnel in general believing in its merit.

Mr. Brown's paper was based upon the premise that, except for the elements of size and weight, the problems involved in the production of automotive apparatus are not dissimilar from those encountered by the manufacturers of portable typewriters. What is known as continuous manufacturing is prevalent in these industries. The Corona Typewriter Co. has 1025 parts to manufacture, 600 of these differing in kind. In connection with these there are about 2500 manufacturing operations, these including all assembling but not inspection; there are about 2000 inspection operations. All operations of a similar nature are concentrated as far as possible in the same department. All factory control is highly functionalized, the plan advocated by F. W. Taylor being followed to a considerable extent.

In preparing the paper for presentation to the Society, Mr. Brown asked the head of each of the Planning Department Divisions to submit a statement of the respective methods followed, together with copies of all forms used. The head of the Planning Department checked the report of each of the divisions and had revisions made when necessary. As editor-in-chief, Mr. Brown combined the reports into the paper. In functionalizing the work, the various subdivisions or sections were placed under the direction of highly trained men of engineering experience or qualifications. The Methods Division was divided into five sections, as follows: (*a*) assembly, (*b*) machine, (*c*) metal-finishing, (*d*) salvage and (*e*) record. The work of the engineers in (*a*), (*b*) and (*c*) is essentially of a non-routine character, the men being primarily free lances in their work. The chief duties of these engineers are to establish efficient methods of manufacture of new parts, to improve methods in use, to test and approve production tools and the like, to investigate complaints, to test materials and to standardize all methods, tools, materials and supplies. The Salvage Section, besides handling the disposal of repairs, determines on the scrappage of parts after analyzing each case and determining whether it is cheaper to repair or to scrap.

Essentials of Reports

In the Corona plant, the experimental department corresponds to the engineering department of an automotive factory. Mr. Brown said that all formal reports made must contain, in addition to the subject and the specification of what is to be done and how, an outline of the available knowledge relating to the subject, a statement of the object in view, an historical sketch of previous investigations and findings, a description of the procedure in the investigation and conclusions and recommendations. The Methods Division keeps in close contact with the purchasing department on matters involving technical points. Mr. Brown said that this is an important matter. The initiative in securing better or cheaper materials or supplies is not left to the purchasing department, but may be in any part of the organization.

In connection with time-studying, Mr. Brown explained that after the demonstrator has had sufficient practise to gain a rhythm of motion, the observer begins the timing of an operation. The operation is divided into as many elements or movements as can be timed effectively. Any time per movement that varies 35 per cent or more from the time selected as the correct time is considered abnormal. In speaking of one operation, Mr. Brown pointed out that 2-per cent personnel, 3-per cent fatigue and 3-per cent machine and tool delay-allowances were made. Two 10-min. rest periods also are provided. The operators are assured that the standard rates and time issued will not be changed unless a radical change in design, machine or method is made. An inexperienced operator is allowed a learning period, according to each case. The use of a daily efficiency record has proved of value; the operators are not only interested in the pay they receive but take pride in achievement.

As frequent changes are made in the design of parts, it is essential that inventories be maintained at the lowest possible minimum and that the stock of material, parts in process and finished parts be well balanced. In the typewriter industry a month's supply of a small part can be turned out in less than an hour. This means that continuous work on any single operation is rare. Most of the parts are produced in lots of 5000 and 10,000. A definite balance of finished parts is kept as a reserve against emergencies, this being in most cases the quantity used in 3 weeks' production.

Control being the vital feature of planning, the control-board of the Corona company is a graphic combination of the parts ledger and the stores ledger. This is a large board around which strings are tied vertically, a pair for each part. The board provides a graphic daily posted inventory. Mr. Brown submitted a chart or form for each important step in the practice of the factory. He emphasized the fact that the only way to understand fully the methods in use is to study these forms. Mr. Feiss said that the value of the methods installed at the Corona factory could be appreciated only after a visit to the plant. One general observation that Mr. Brown made was that orders are pulled and not pushed through the factory. An important condition is that no parts are filed or sawed by hand, all of the component elements being interchangeable under the system of standardization maintained. Inasmuch as all materials, supplies, type, and key cards are checked through a continuous inventory so arranged as to be completed every 6 months, no other inventories are taken. The Stores Division is expected not merely to keep an adequate supply of all items under its control but also to assist in keeping all stores at the minimum. Mr. Brown said that the whole system which he described is being maintained at a minimum of inconvenience, without causing any shutdowns and with considerable smoothness and economy.

STANDARD VERSUS SPECIAL MACHINES

Quantity Output Possibilities of Each Type Discussed at Production Meeting

Maximum production from factory equipment means versatility in the possible application of certain machines and reasonable adaptability for all machines. Without these qualities the equipment cannot turn in the greatest earnings to the manufacturer. At the Production Meeting, held last year in Detroit, there was started a discussion of standard versus special machines. This question is again taken up in the paper on standard machines for quantity production by Ralph E. Flanders, of the Jones & Lamson Machine Co., who is also president of the National Machine Tool Builders' Association.

After reviewing briefly the question of merits of standard versus special machines as presented at the 1922 Production

Meeting, Mr. Flanders considered, from the machine-tool builders' viewpoint, the problem of so designing and building machine tools as to retain the favorable points of standard machines without sacrificing the advantages of special adaptability and economy characteristic of the ideal special machine. Two possible solutions of the problem were cited; (*a*) building semi-special types of machines from standard units and (*b*) building standard machines with universal foundations upon which highly specialized tool equipment can be mounted. The turret lathe and the automatic lathe, built by the company with which the author is associated, were described and illustrated as representative examples of the two types above mentioned. He enumerated the essential features of the design of these machines and then outlined briefly the advantages of standardized equipment. In the course of his paper Mr. Flanders mentioned the fact that machine-tool builders are now introducing systems of quantity production that are very similar to those already in force with the automotive manufacturers.

R. E. FLANDERS

In conclusion the author suggested that, as part of future Production Meetings of the Society, one or two sessions devoted to the processing and tooling for a single typical part, such as a two-part differential housing or a crankshaft, be arranged.

The discussion brought out more clearly a number of important details of design as well as numerous examples and specific applications of the machines to particular jobs. K. L. Herrmann who presided at this session, called the attention of the members to the importance to the tool designer and maintenance man of the standardization of tool bits as used on the machines described. He also recalled the fact, as previously mentioned by Mr. Flanders, that in some instances the machine capacity is greater than the capacity of the article to withstand the strain of production; this raises the question of suitable design of parts that can utilize the productive capacity of the machines.

HOW TO USE THE SCLEROSCOPE

Instrument's Inventor Says That Methods of Application Should Be Standardized

Hardness determination has long held a place of great importance among engineering inspection tests. It presents problems that are not as yet completely solved, but that still attract the interest of all practical engineers. Albert F. Shore, president of the Shore Instrument & Mfg. Co., inventor of the scleroscope bearing his name, has done much toward solving this problem, and the Society considered it a privilege to have for the Production Meeting his paper on the Standardization of Methods of Applying the Scleroscope that is printed on p. 409 of this issue of THE JOURNAL. Pursuant to the author's desire, L. C. Hill read the paper while Mr. Shore handled the discussion. Several points raised by the Iron and Steel Division of the Society's Standards Committee were discussed by the author. As regards the plumbness of the instrument at the time of hammer drop, it was stated that in addition to the errors in the drop caused by holding the instrument out of plumb, the difficulty of having fluctuations in the readings was encountered, thus making a comparison of the results difficult. A marked effect was said to result from lateral vibrations. It was also stated that the effect of surface roughness of the specimen is not as great as is usually supposed, that careful polishing is not necessary and that under proper conditions of test the scale on the surface of steels in the soft condition has but a slight influence on the readings of the instrument. Other topics included the condition of the diamond point, the effect of mass of the test-specimen, extreme under-weights, inert and over-weight masses, the effect of hardness on mass, the thickness of the test-specimen, testing near specimen edges, the effect of curved surfaces and how specimens are mounted. One of the most interesting parts of the paper dealt with comparisons between Brinell and scleroscope hardness determinations. A conversion chart, tables and other material bearing on this subject were presented.

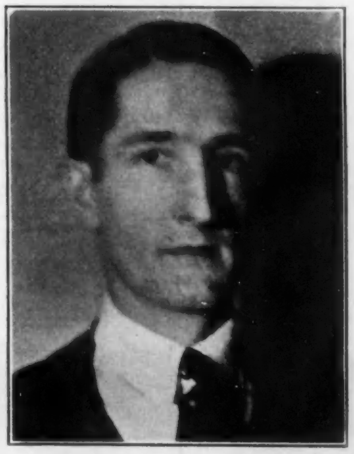
A. F. SHORE

The discussion covered a wide range of questions relating principally to the methods of using the scleroscope and mounting the specimens. With regard to the effect of weather conditions on the indications of the instrument, Mr. Shore stated that no effect was noticed unless actual drops of moisture collected in the tube and thus interfered with the hammer travel. It was also pointed out that for special tests, such as those on carbon, a specially-fashioned diamond-point is necessary.

MEASURING OUT-OF-ROUNDNESS

Governing Factors and Inspection Methods for Various Types Outlined

In his paper on Factors Governing "Out-of-Roundness" Measurement, A. H. Frauenthal, chief inspector of the Chandler Motor Car Co., dealt with so-called "regular" types of "out-of-roundness", that is, with high and low spots following some mathematical continuity. He linked certain types of out-of-roundness with the types of machine on which the work was mounted. For example, on work that comes out-of-round from a centerless grinding machine, the high spots and low spots appear in multiples of three. This the author attributed to the three points of pressure in the machine, namely, the grinding wheel, the feed wheel and the work support. The importance of properly selecting and using gages and measuring instruments for checking out-of-roundness of various types was mentioned. The topics discussed in this connection were the three-point measuring system, errors of the V-block method, elliptical objects in a V-block, other methods for checking elliptical forms and indicator-reading correction. In conclusion the author suggested the following three items as worthy of consideration by the manufacturers; (*a*) a flat measuring-point large enough to reach the major diameter when it is off-center with the measuring-point due to ellipticity, (*b*) a revolving characteristic of the measuring-point to pro-



A. H. FRAUENTHAL

mote even wear, and (c) a corrected indicator for use with the 90-deg. V-block, thus eliminating correction by the operator.

In awaiting the preparation of question cards, Chairman Herrmann spoke of the very appropriate assignment by the meetings Committee of topics for production papers at this year's meeting. He called attention to the fact that the problems had been those of live interest to the practical engineer and that they had treated the human side of production, the academic and scientific interests and the strictly mechanical phases of production work.

In the discussion of Mr. Frauenthal's paper, the question of out-of-roundness tolerances was considered. It was agreed that the slight out-of-roundness obtained by present production methods on well-maintained and adjusted machines is practically negligible. The importance of not crowding machine tools such as grinding machines was also mentioned.

COMPANY ORGANIZATION FOR PROFIT

Principal Topic of the Address Delivered by R. H. Grant at the Production Dinner

In addressing the members at dinner on Friday evening, R. H. Grant, general manager of the Delco-Light Co., took as his subject Management. In his introductory remarks he said that "scientific" management is apt to result in overlooking main issues, and that the best combination is science and horse-sense.

Mr. Grant reiterated what he stated emphatically at the 1922 Service Dinner of the Society in Chicago, namely, that company organization consists of four divisions devoted to engineering, finance, manufacturing and sales, respectively; the prime purpose being to produce a return on capital exceeding that available from investment. There is a tendency in a highly specialized business for the men in the different divisions to become so wrapped up in their immediate work that they overlook the real reason for the existence of the business.

Mr. Grant divided management into two classes: (a) strong general management, that effects hard enough work in each department; (b) management that selects as subordinates men who are not only qualified as specialists but able to understand the main problems of the company. He said that any business can be successful when well conducted but that the best results are secured by virtue of the cleverness with which plans are carried out rather than of the merit of the plans themselves. The proper work of the financial department in connection with the granting of credits is, for example, to keep the loss from bad debts sufficiently low and still permit the total amount of business to increase. The men in the different departments should exert their intelligence in the highest degree possible. The salesman should cooperate with the financial department to secure business according to approved business principles. If the chief engineer understands what article will secure the greatest sales, it is his duty to design this. There must be coordination of interests between, as well as clever work by specialists in, all the main divisions of the business to make the whole general scheme adequately profitable. The production man should not be autocratic but give due consideration to the experience and the ability of others in the organization. There must, of course, be a clear understanding throughout the company of what the undertaking in hand is, how much the investment is and what and how much must be produced. The program must be decided upon 3 months in advance of the beginning of a given manufacturing year. Then calculations can be made as to how much direct labor will be needed, what overhead-expense burden can be assumed and how extensive a sales organization is needed. Those in the selling field should be told what they must do to meet the various quotas involved in the plan. Maintenance expense must be analyzed and advertising cost decided upon. The general manager must watch constantly the degree of progress made in each of the departments. Minimum figures of performance for the future should be set for the length of time feasible and in such amount that the men concerned will endeavor to exceed them. Forecasting is an essential part of good business. The carrying out of a definite 4 months' schedule usually means more profit than is gained in production according to a variable monthly program. A whole year's work should be accomplished without interruption. The type of a business determines how far in advance a production schedule can be planned. The most gratifying results are secured when many minds are concentrated on one specific purpose. All are in business to attain the highest personal success possible. A man can help himself best by contributing something that redounds to the greater profit of the company.

President H. W. Alden R. H. Grant
THE TOASTMASTER AND THE SPEAKER AT THE PRODUCTION DINNER

President Alden was toastmaster at the dinner. Jack Raper, humorist of the Cleveland *Press*, amused the members by showing that prohibition is too serious a thing to joke about and making observation on other live issues of the day.

FOUR CLEVELAND FACTORIES VISITED

Members Inspect Automobile, Truck, Steel and Malleable Castings Plants

About 100 members and guests attended the factory visits that were a part of the Cleveland Production Meeting. Orrel A. Parker, chairman of the Factory Visit Committee, arranged to have motorbuses and cars convey the members in groups to the several factories and dispatched these on a prompt schedule. The factories visited included the American Steel & Wire Co., the Chandler Motor Car Co., the National Malleable Castings Co. and the White Motor Co.

Visitors to the plant of the American Steel & Wire Co. saw large rolls squeezing out thin sheets of hot-rolled steel that were to be stamped out eventually in huge presses to form the panels for automobile bodies. Bar stock of various shapes and sizes was also being passed through the mill at the time of the visit. The members were high in their praise of the courtesy extended them by the factory officials.

Apparently a majority of the members were interested in automobile construction, for the visit to the Chandler plant attracted over 60 men. They were transported to the factory in cars provided by their hosts and were given a courteous welcome by J. R. Hall, vice-president and factory manager. Responsible factory executives showed the visitors every nook and corner of the large Chandler plant, the crowd being divided up into groups of four or five each. Great interest was shown in the modern conveyor systems used in the handling of the Chandler product both in the carrying of the parts and for the assembly of the bodies and complete vehicles.

One of the largest continuous annealing furnaces in the

world was seen by the members who visited the foundry of the National Malleable Casting Co. They were very favorably impressed by the foundry methods in use by this organization.

The visit to the White factory was added as an extra feature because many of the members desired to inspect this plant. Some 30 men availed themselves of this opportunity to see one of the largest motor-truck factories in the world.

Appreciation must be recorded here of the courtesy and hospitality of these four Cleveland factories and their officers. In every instance, the visits were handled expeditiously and questions were answered courteously and fully.

A FEW WORDS OF GRATITUDE

Meetings of the Society are successful largely because of the voluntary efforts of those of its members who take an active part in the preliminary arrangements and the conduct of the social and professional programs. In the case of the Production Meeting at Cleveland, Oct. 25 and 26, unusually able and earnest cooperation was shown by the officers and members of the Cleveland Section. John Younger deserves mention for the assembling of several energetic committees and instilling their members with enthusiasm in the meeting's work. Orrel A. Parker arranged all of the visits to the Cleveland factories and organized the transportation in an effective way.

Much favorable comment was voiced by the visiting members on the congenial and helpful work of the large Reception Committee that greeted the men as they arrived, aided them in registering and assisted in running the several meetings and the dinner on schedule time. This committee was headed by H. J. Monson and consisted of E. W. Austin, R.

H. J. Monson O. A. Parker
TWO OF THE COMMITTEE CHAIRMEN WHOSE EFFORTS WERE LARGELY RESPONSIBLE FOR THE SUCCESS OF THE MEETING

S. Begg, M. Bleiweiss, T. V. Buckwalter, W. T. Cogger, A. M. Dean, E. E. Eyeman, C. A. Michel, R. J. Nightingale, Clyde Pelton, A. J. Scaife and Arthur Skinner.

It is also appropriate to record the Society's appreciation of the interest of the authors in preparing and presenting their valuable papers. Acknowledgment is made of the cooperation of the Taylor Society in securing a paper from one of its members for presentation at the Scientific Management session. Last, but by no means least, the Meetings Committee of the Society deserves mention for its continued good work.

BODY NOMENCLATURE

THE following editorial, which is reprinted from the October, 1923, issue of *Autobody*, will be of interest in connection with the recent action of the Passenger-Car Body Division in approving of the term "coach" as a body designation. An article outlining the action taken will be found on p. 417 of this issue.

The National Automobile Chamber of Commerce, through its service division, has suggested to the Standards Department of the Society of Automotive Engineers that a standard name be selected for the enlarged coupes put out by Hudson, Essex, Nash and others under the names of "coach," "brougham," "carriole," etc. We do not know whether this is intended as a joke by the car builders, or whether the service departments are having to bear the brunt of the confusion and have arisen to protest against the foolishness of calling a coupe a sedan, and vice versa. If it is a protest against the confused condition of our nomenclature, that protest should be lodged with the car builders whose sales departments have been the chief sinners.

The abolition of "pleasure car" was a long-drawn and costly struggle, if measured in luxury taxes, and this old-time offender has not yet been completely estopped. Until the sales and sales-promotion departments clean house, there is little hope of clearing up body nomenclature.

At the time the present S. A. E. nomenclature was adopted, no definite names were selected for the so-called "coach" and the "close-coupled sedan" because it was then felt that these were more or less ephemeral types. This lack of leadership, however, has resulted in much confusion in the names of the intermediate-sized closed bodies. One now hears of "four-door coupes" and "close-coupled sedans" as the designation for the same body, and as for the two-door five-passenger model, with individual front seats and a rear cross-seat, it is called a five-passenger coupe, a touring sedan, a brougham and other names too numerous to record.

The first-mentioned type of body arranged for four or five passengers appears in a fair way to become the standard size of sedan bodies. It is a mystery to us why these four-door closed models cannot be satisfactorily designated as five- or seven-passenger sedans. With reference to the two-door models, the naming of these has run wild for so long that there will be much inertia to overcome in establishing any one of the existing names unless we adopt "coupe" already used to a considerable extent with a qualifying designation to indicate the seating capacity. "Coach," "brougham" and "touring sedan" would seem to be disqualified for the reason that these terms are already used and needed for other vehicles.

THE AMERICAN WORKINGMAN

THE American workingman is better off today than he ever was before. During the first half of 1923 increased pay and a higher level of hours worked resulted in substantially increasing earnings. The comparatively small increase in the cost of living for the same period materially increased the weighted or "real" earnings, which reached levels well above those attained during the months of so-called peak wages in 1920. In June, 1923, the "real," or weighted, hourly earnings were 40 per cent above the 1914 level and the weekly earnings 35 per cent higher.—*Economic World.*

THE UNITY OF SOCIAL INTERESTS

SINCE the time of Malthus the achievements of scientific research have given a larger view of the potential command of man over the resources of nature. Institutions are demonstrating that agriculture is a science, the possibilities of which may be limitless. Moreover, the improvements in methods of transportation since the time of Malthus have been revolutionary, thereby facilitating both the spread of population over unsettled areas of land and the transportation of food products from the new countries to the old, where the problem of food supply is pressing.

So influential have been these changes that the Malthusian doctrine in recent years have come to have not much more than a historical interest, and yet it contains a truth of fundamental importance. The population is rapidly increasing, the area of land is limited, and in the long run it is only by increasing mastery of the secrets of nature, more efficient methods of cultivation and a higher intelligence throughout the body of the population that the conditions depicted by Malthus can be averted.

We have a vast area of land yet to be brought under cultivation, but most of it is either of inferior quality or will require a large expenditure of labor to fit it for use. It is in competition with these lands that Iowa farms have been bringing $200 and $300 per acre.

Every census has shown a smaller percentage of our people engaged in agriculture, and at the last count less than one-third were actually living on farms. This reduction of the proportion of the population upon the farms, because a smaller number are able to supply the required amount of farm products, is not something to be regretted. A great development of the other industries has been made possible and has brought into common use a vast number of comforts and services that our fathers knew nothing of. It has raised the standard of living for the population, but this is mainly because we have been able to spread our farming operations over more land. I am not sure that the yield per acre on the whole has increased, and to offset a growing population we need an increased yield per acre without higher costs. I doubt if the fertility of the soil is being maintained. I believe that the quality of our live stock has been improved, thanks to the leadership and the influence of the agricultural colleges and the labor of many other devoted men who have been identified with the industry. But after all is said, the ability of our agriculture to keep production up to the demands upon it has been dependent up to this time mainly upon spreading over more land, and that means to lands of lower productive capacity than those in use heretofore, and higher costs unless we improve the methods. And all experience shows that it is a slow task to change the habits and customs and raise the average productive capacity of a great body of people.

We know that the prices of all natural products have been increasing and were on a rising scale even before the phenomenal increases that resulted from the war. Over against these tendencies we have the influence of improvements that may be made in the methods of production and distribution, the results of invention, of scientific research and of the accumulation of wealth in the form of productive equipment. The net result of these two sets of influences determines whether society moves forward or backward. Unless we develop greater harmony and efficiency in industry and leave to those who come after us an inheritance of knowledge and of industrial equipment greater than we received, we shall simply have exploited this Country and left our successors with a greater population to face harder conditions of life than we have known ourselves.

There is more gain for the members of any group or class in promoting the efficiency of the organization as a whole than in attempting to promote the interests of their own group by means that impair the efficiency of the whole. There is a just relationship between all the branches of industry and business, the maintenance of which is worth more to everybody, by promoting general prosperity, than any special advantage can be worth.

The highest state of prosperity results from a balanced state of industry. We know that to obtain the best results in an individual industry all departments of the industry must be in balanced relations to each other; and so there is a normal equilibrium throughout industry that must be maintained to have prosperity. All business in the last analysis is simply an exchange of goods and services; and this being true, all branches of industry must be so related that the products of every industry will be absorbed and consumed by the people in the other industries. This means that their interests, instead of being antagonistic, are necessarily interlocked and dependent upon each other. An injury to one affects them all.

Before the war a great volume of mutually beneficial international trade had been developed. Europe was the center of the world exchanges. It was constantly receiving great quantities of foodstuffs and raw materials from all parts of the world and paying for them by sending out manufactured goods. The war disrupted that trade. Russia was an important factor in that trade with Western Europe, and Russia has been practically eliminated for the present. It might be thought, at first, that since Russia was the principal competitor of the United States in the exportation of foodstuffs, the disappearance of Russia would be beneficial to the farmers of this Country; but we know that our farmers are not so well off as before the war. That is because the disappearance of Russia as a market has injured the manufacturing industries of Europe, so that their purchasing power is less than before. The whole situation is too disorganized for anybody to gain by it.

I think most of our troubles are due to the fact that we have developed the industrial organization beyond the understanding of the ordinary man. He does not know his own part in it; he does not realize the benefits that he gets from it; and you cannot expect men to be loyal to something they do not understand.

The greatest obstacle to social progress is the want of understanding and of the spirit of cooperation that depends upon understanding. The system under which men give their lives to the pursuit of knowledge or the development of skill in special lines is dependent upon the spirit of cooperation and of fair play. It depends upon mutual confidence and good faith. We must trust each other or go back to the primitive conditions of life.

It is a strange fact that the world is haunted with a fear of over-production, although there is scarcely a person in it whose wants are fully satisfied and the great mass of the people are in want of common comforts. The truth is that over-production is inconceivable. Unbalanced production there may be and frequently is, this Country having suffered from it in the last 2 years; but over-production there cannot be while human wants are unsatisfied.—From an address by George E. Roberts at Iowa State College of Agriculture.

TRANSPORTATION

FOR the decade ended with 1910, highway transport commanded about one-third of the capital put into railroads; in the decade ended with 1920, it commanded four times as much capital as railroads, that is, approximately, $16,000,000,000, out of a total for all transportation of $23,000,000,000, against $4,000,000,000 for railroads. These facts indeed challenge attention. Although the gross railroad investment per ton handled has decreased from about $17 in 1880, to about $8 today, little reduction has been made within the last 20 years, in spite of greatly increased traffic and efficiency, a fact that seems to indicate that the majority of the new capital has gone into expensive terminals, which is also indicated by an analysis of the track-mileage additions through the years.

Transportation is the second industry in the United States, costing, approximately, $50,000,000,000 to build, which is about twice the National debt. It is next to agriculture, $80,000,000,000, and exceeds manufacturing, $45,000,000,000. In general terms, the cost ratio is approximately 2:2:1 for railroads, highway transport and other agencies respectively. This great transport plant has grown from $14,000,000,000 in 1900 to $26,000,000,000 in 1910, and $50,000,000,000 in 1920. Railroads held the stage from 1900 to 1910 and highway transport and shipping since 1910. It would be a wise prophet who could foretell the future cost of highway transport.

If all transportation increased only as fast as the railroads, by 1940, $25,000,000,000 of new capital will be required at the minimum, with probably $25,000,000,000 more for replacements of depreciable property retired. It is incredible that railroad development will recede. It is more likely that other transport will advance, so that these total figures are probably much too conservative. Does not the fact that the cost of the highway-transport plant has grown to nearly that of the railroads and possibly 40 times that of inland waterways construction emphasize the need of a broader treatment of transportation in the future so as to include not only the "arteries" but also the "heart" and the "capillary system"?

The traffic of the Nation has grown in geometric ratio to the population, while facilities in freight-houses, team-tracks, wharves, transit lines and particularly streets and roadways in the large centers have increased, if at all, only in arithmetic ratio. Thus, railroad tonnage has increased nearly as the cube, and ton-mileage nearly as the fourth power, of the population. Terminal tonnage is probably increasing as the cube of the population, especially in view of the growing proportion of city population to the total in the Country. Motors, however, are increasing far beyond the fourth power of the population and city motors probably as fast if not faster. Nevertheless, in the majority of the cities, practically nothing is being done to survey and develop the capacity of the street system for handling this enormous flood of passenger and freight traffic, for transfer and city destination. Instead, building heights are being forced upward, which only intensifies the problem.

The larger question of future transport will undoubtedly focus in the terminals and some form of physical, financial or operating unification will be evolved to ensure command of the transport situation; that is, terminal evolution in the gateways and large centers offers the greatest opportunity of increased capacity and minimum investment in which ship, barge, motor and trolley, as well as rail, must each play its part. Here, in a large degree, lie the controllable wastes in transportation, both off and on the rail, and it is evident that the maximum efficiency of the arteries of commerce, the rail lines, can never be secured until the heart of the system, the terminals and their distributing agencies, are able to function as they should.

Just before the World War, a survey of less-than-carload freight movement in Chicago showed that 60 per cent was transferred through the city to connecting roads, more than half of it by trucks using the down-town business streets and less than half by trap-cars and freight tunnels. In Cincinnati, this trap-car freight is now being handled between various stations by motor cars with interchangeable bodies. This points clearly to the need of trucking by pass streets and detour routes, avoiding the central districts and yet giving the motor freight a chance to reach all parts of the city with reasonable speed. In Chicago, the first enterprise of this kind, known as the South Water Street Improvement, has been started. This will provide a wide double-deck detour thoroughfare around the Loop District, next to the river bank, with high-speed vehicles above and trucks below. In addition, it will provide a very large automobile storage capacity at the boundaries of the Loop District for all-day storage of business-men's cars, thus entirely avoiding the terminal congestion.

America has only one great long haul internal waterway, the Mississippi River and its tributaries, with its new canal connection with the Great Lakes. Such a waterway naturally constitutes a great intercepting trunk-line for through movement in large units between strategic rail-connecting points. It is difficult to understand how such a waterway system can ever become of the maximum utility without joint rates and through routes with the railroad system, due to the comparatively limited littoral that can be served by the waterways. In the interest of National efficiency, it would seem that all the people should have the advantage of water transport where they can use it to advantage. Under such circumstances, it is logic and justice that the economies of water transport that will develop automatically with increased traffic should be reflected back into the railroad system in some equitable manner through rates, so that both rail and water-haul may participate in these economies.

Outside the Mississippi System, the Warrior is the longest navigable river, not even excluding the Hudson. This means that the majority of the inland rivers will be confined to local, or comparative short-haul, tonnage which must stop at the seaboard until the intra-coastal canal system is developed as a water belt-line interconnecting all these river estuaries with one another and with all seaboard ports and cities. As this whole waterway system matures and tonnage develops, water transport may reveal unlooked-for economies, especially if it is linked up with railroad hauls where economic conditions warrant.

The total cost of developing and maintaining the inland waterways of the Country, excluding harbors and estuaries, since the beginning of the Nation's history is probably not more than one-half of what the Country spends in 1 year on public roads and will spend on railroads for the next year. The great problem of the collection and the distribution of rail freight rests largely on the highways. It costs the Country as much to haul freight to and from the railroad as to haul it on the rails and in the end the highways must transport the greater part. Motor competition with the railroad sinks into insignificance beside the larger problem of efficient terminal collection and delivery. The economic relation of long and short-haul costs, road versus rail, is rapidly being developed by the Connecticut road-tests and other studies and will soon be reasonably well known.

A better organization of the off-rail movement to and from the railroads will soon be needed to release the full line capacity of the latter and enable the terminals to operate in movement rather than storage. This will provide a quicker, turn-around, not only for cars, but also for ships and motors themselves. It will provide the much needed "vacuum pump" to clear the terminals more promptly.—From a paper presented by J. R. Bibbins before American Society of Civil Engineers.

STANDARDIZATION

STANDARDIZATION, per se, is not static; it is dynamic. It is the continuous process of crystallizing the best thought and practice of the industry or the art, and coincidently eliminating that of proved lesser quality, utility, or value as uneconomic, wasteful and destructive. Standardization is the logical outgrowth of constructive effort, it is the measure of progress and the incentive for further advance. For no sooner has any one thing reached a certain degree of attainment or perfection than effort is concentrated in, and applied to, the problems of refining, improving and developing that thing to higher limits of performance, utility and satisfaction.

Standardization may begin at any point in the circle of commerce. In some cases efforts have been successfully directed at some specific features of the article, or phase of the process, under consideration without regard to the other existing variants. In other cases the primary effort has centered on the elimination of superfluous and unnecessary existing varieties in a common field of endeavor to the end that all such extraneous matters may be disposed of preparatory to intensive concentration of the varieties remaining. No matter which course is first chosen, the ultimate result is the same, for just as proved and demonstrable refinement causes the elimination of the unfit, so does such elimination induce improvement and advance in those that survive.

Managers everywhere are urgd to apply standardization as an effective means to eliminate waste. Products should be standardized consistently with the progressive development of manufacturing. Materials should be standardized to the fewest practicable kinds, sizes and grades. The details of equipment, including machine and tools, should be standardized so as to permit the widest interchangeability and the maximum usefulness consistent with improvements in design and invention.

Manufacturers may well be interested in the benefits of standardization, or "simplified practice," which term is more truly expressive of its purpose, for while manufacturers are primarily concerned with production, continuous operation of their plants rests on adequate distribution and steady consumption. Simplification, once started in any line, reaches into all three fields and with its progressive application brings numerous benefits that can be measured in dollars and cents.

Secretary Hoover has organized the division of simplified practice in the Department of Commerce to serve as a centralizing agency in bringing producers, distributors and users together and to support the recommendations of these interests when they shall mutually agree upon simplifications of benefit to all concerned. Nearly a hundred different trade associations are utilizing the services of the Division in carrying on their simplified practice program.

To date paving bricks have been reduced from 66 to 7 sizes. Wood beds and metal beds now have one common length with four standard widths for the former and two for the latter. The manufacturers of springs and mattresses favored this action, and now their products are being made in sizes to conform to the simplified line of beds. Metal lath varieties have been reduced from 80 to 12, and several other simplifications are in process of completion. These lines include lumber, bed blankets, milk bottles and caps, paint, oil and varnish, containers of all kinds, automobile parts and accessories, shipbuilding supplies, construction materials, contractors' equipment, oil-well supplies and equipment and many others.

Our material supplies should not be consumed in the fabrication of wasteful or slow-moving lines; neither should our relatively limited labor resources be applied to the production and the sale of such articles or commodities. Nor should our already congested transportation facilities be further clogged by the movement of such goods. We need to make a greater and more intelligent use of existing facilities and resources toward supplying the most common human wants. By so concentrating our effort, we can release a large amount of human thought and energy toward the development of new arts and sciences, social betterments and the improvement of standards generally.—R. M. Hudson in *American Industries*.

FRANCE'S FINANCIAL SITUATION

IN less than three years after the armistice, France has been able through the activity and the perseverance at work of her population to re-establish her foreign trade and her economic situation.

While this effort was made, reconstruction of the devastated area was carried on without interruption. The following comparative statement of destruction suffered and reconstruction effected up to the end of 1922 will indicate to what extent the work has been completed:

Buildings destroyed or damaged,	741,993
Rebuilt and repaired,	553,977
Land devastated, hectares,	3,306,550
Restored, hectares	3,018,000
Roads, railways, bridges, tunnels destroyed, km.,	68,237
Rebuilt and repaired, km.,	42,652
Canals, locks, bridges, destroyed or damaged, km.,	2,349
Rebuilt and repaired, km.,	1,960

The cost of this reconstruction amounts to about 80 billions of francs, and in accordance with the terms of the Treaty of Versailles should have been borne by Germany. It is these 80 billions of francs which today weigh down on the financial situation in France and will delay her complete recovery until a definite settlement is made; while to finish the reconstruction it will still be necessary to raise another 40 billions of francs.

It is necessary to emphasize, in making an analysis of the situation, the fact of the great power for saving of the French population. The saving power is estimated at some 30 billions of francs yearly; and such is the confidence of the people in overcoming the present difficulties that internal loans issued by the Government have always been absorbed readily. The total amount of these internal loans subscribed during the war and after the war stands at francs 99,791,000,000 for the consolidated debt, while the floating debt amounts to francs 101,000,000,000.

The economic situation of a country bears a direct influence on its financial situation. If the former is sound the latter, even though momentarily embarrassed, will gradually improve when every effort tends in that direction. This is the case of France; and the material progress made so far, under exceptional and trying conditions, should justify every confidence as to her ability in re-establishing her financial situation as she has rebuilt her economic situation.—Paul Duran, president French American Banking Corporation.

Applicants *Qualified*

The following applicants have qualified for admission to the Society between Sept. 10 and Oct. 10, 1923. The various grades of membership are indicated by (M) Member; (A) Associate Member; (J) Junior; (Aff) Affiliate; (S M) Service Member; (F M) Foreign Member; (E S) Enrolled Student.

Affleck, Edward T. (M) general manager, Dé Jon Electric Corporation, *Poughkeepsie, N. Y.*

Banes, William K. (J) automobile electrician, Ditch Bowers & Taylor, Inc., *Baltimore, Md.*, (mail) 319 East 24th Street.

Blackeby, F. Walter (A) manager of sales electric steel department, Eastern Steel Castings, Inc., Newark, N. J., (mail) 643 West 215th Street, *New York City.*

Bronson, Adelbert E. (A) secretary, Dill Mfg. Co., 7114 Carnegie Avenue, *Cleveland.*

Chase & Co., L. C. (Aff) 89 Franklin Street, *Boston.*
Representatives:
Hopewell, Frederick C., partner.
Hopewell, Henry C., partner.

Cherry, George H. (A) sales engineer, American Bosch Magneto Corporation, 5810 Woodward Avenue, *Detroit.*

Cisler, Walker L. (J) cadet engineer, Public Service Electric Co., *Newark, N. J.*, (mail) 45 Thomas Street.

Cobb, Francis S. (A) president and treasurer, Seamans & Cobb Co., 140 Essex Street, *Boston.*

Coshof, M. E. (E S) student, Tri-State College of Engineering, *Angola, Ind.*, (mail) P. O. Box 253.

Davis, Jack B. (A) production manager, Standard Textile Products Co., *Buchanan, N. Y.*

Dettlinger, F. W. (J) laboratory engineer, Plant 5, Studebaker Corporation, *Detroit*, (mail) 705 Y. M. C. A. Building.

Edinger, Edward Peter (J) student engineer, Franklin Auto Co., *Syracuse, N. Y.*, (mail) 500 Rowland Street.

Grabfield, John J. (E S) student, Massachusetts Institute of Technology, Cambridge, Mass., (mail) 1933 Commonwealth Avenue, *Boston.*

Hall, H. R. (A) assistant to general service manager, New York Yellow Cab Sales Co., Inc., *New York City*, (mail) 604 West 140th Street.

Homan, A. E. (A) general manager, C. G. Spring Co., 1825 East 13th Street, *Cleveland.*

Knight, Boyce W. (A) sales manager, Ensign Carburetor Co., Los Angeles, (mail) 3108 South Michigan Avenue, *Chicago.*

Lake, Harry W. (A) inspector of aeronautical engines, engineering division, Air Service, McCook Field, Dayton, Ohio, (mail) care of Curtiss Aeroplane & Motor Co., 74 Kail Street, *Buffalo, N. Y.*

Lemon, Burton J. (M) technical service department, United States Tire Co., 1790 Broadway, *New York City.*

Miller, Walter (M) manufacturing manager, Marland Refining Co., *Ponca City, Okla.*

Muller, Joseph J. (M) designing engineer, Belmont Motors Corporation, *Lewistown, Pa.*

Newton, F. I. (A) secretary, G & O Mfg. Co., 598 State Street, *New Haven, Conn.*

Ottenhoff, W. B. (A) manager of engineering service division, Indian Refining Co., Inc., 244 Madison Avenue, *New York City.*

Panek, Emil (A) engineer, Globe Machine & Stamping Co., *Cleveland*, (mail) 9608 Baltic Road.

Parker, Arnold George (A) designing draftsman, Manly & Veal, New York City, (mail) 3737 45th Street, *Corona, N. Y.*

Peterson, Eyvind (A) die-casting engineer, Fairbanks, Morse & Co., *Beloit, Wis.*, (mail) 1418 Hull Avenue.

Robinson, Richard Herbert (E S) student, Tri-State College, *Angola, Ind.*, (mail) P. O. Box 204.

Schroeder, A. F. (A) chief inspector, Falls Motors Corporation, *Sheboygan Falls, Wis.*

Sherman, E. A. (A) district manager, Westinghouse Air Spring Co., Bridge Plaza, *Long Island City, N. Y.*

Sherwood, H. H. (A) president, Sherwood Petroleum Co., Inc., Building 1, Bush Terminal, *Brooklyn, N. Y.*

Vanatta, Jean K. (M) mechanical engineer, Mudge & Co., 4425 West 16th Street, *Chicago.*

Warner, John A. C. (M) assistant research manager, Society of Automotive Engineers, Inc., *New York City*, (mail) 625 West 169th Street.

Webster, H. G. (M) consulting engineer, 1427 Monadnock Building, *Chicago.*

Wisconsin Steel Co. (Aff) 606 South Michigan Avenue, *Chicago.*
Representative:
Courtright, B. F., metallurgist.

Applicants *for* Membership

The applications for membership received between Sept. 14 and Oct. 15, 1923, are given below. The members of the Society are urged to send any pertinent information with regard to those listed which the Council should have for consideration prior to their election. It is requested that such communications from members be sent promptly.

AFFLECK, BERTRAM L., manager, Holmes Vocational School, Inc., *New York City.*

ATKINSON, E. S., sales engineer, H. B. Sherman Mfg. Co., *Battle Creek, Mich.*

BAILEY, ROBERT WILLIAM HARVEY, technical production engineer, Rolls-Royce, Ltd., *Derby, England.*

BOCK, GEORGE E., student, Columbia University, *New York City.*

BOSSI, ENEA, president, Self-Feeding Vaporizer Corporation, *New York City.*

BOUTON, EUGENE, supervisor of time study, Chandler Motor Car Co., *Cleveland.*

BRUSSELL, JOHN W., assistant works manager, Timken-Detroit Axle Co., *Detroit.*

BRYAN, GEORGE A., vice-president and general manager, Bryan Harvester Co., Inc., *Peru, Ind.*

CAMERON, WILLIAM BISSET, automobile engineer, Cameron Garage, *Montreal, Canada.*

CLEMONS, H. E., general superintendent, Motor Transit Co., *Los Angeles, Cal.*

COYNE, J. HEBER, automotive engineer, D. McCall White, *Detroit.*

DAY, THURMAN O., master mechanic, Yellow Cab Co., *Philadelphia.*

DOWNEY, WILLIAM D., draftsman, Philadelphia Motor Coach Co., *Philadelphia.*

DRAKE, CHARLES LAURANCE, sales engineer, S. K. F. Industries, Inc., *New York City.*

DUNLAP, GEORGE A., draftsman, Fisher Body Corporation, *Detroit.*

FITZNER, B. F., manager, Vesta Battery Corporation, *New York City.*

GASSNER, ALFRED A., designing engineer, International Motors Co., *New York City.*

HANSEN, H. A., manager, Stromberg Motor Devices Co., *Detroit.*

HOBSON, G. B., engineer, Brewster & Co., *Long Island City, N. Y.*

ILLINOIS STEEL CO., *Chicago.*

JOHNSON, FORREST L., student, Tri-State College, *Angola, Ind.*

KRIEGBAUM, ASA WALTER, student engineer, Remy Electric Co., *Anderson, Ind.*

KROUKOVSKY, B. V. KOVIN, designing engineer, Aeromarine Plane & Motor Co., *Keyport, N. J.*

LLOYD, ARTHUR G., estimator, Wright Aeronautical Corporation, *Paterson, N. J.*

McCALMONT, A. W., vice-president and chief engineer, Briscoe Devices Corporation, *Pontiac, Mich.*

McEWING, JAMES P., designing engineer, Sawyer-Massey Co., *Hamilton, Ont., Canada.*

McKEON, WILLIAM O., assistant chief draftsman, Walden-Worcester, Inc., *Worcester, Mass.*

NATIONAL AUTOMOBILE UNDERWRITERS CONFERENCE, *New York City.*

NORBERG, G. HAROLD, superintendent, Huck Axle Corporation, *Chicago.*

PERCIVALL, J. J., superintendent of transportation, New York division, Gulf Refining Co., *New York City.*

PRONER, DANIEL A., mechanical engineer, Hyatt Bearings Division, General Motors Corporation, *Harrison, N. J.*

REAGAN, NEAL FRANCIS, assistant general service-manager, Yellow Cab Co., Sales Agency, *New York City.*

SEWARD, STANLEY P., advertising manager, White Co., *Cleveland.*

SHERE, A. T., mechanical superintendent and designing engineer, California Transit Co., *Oakland, Cal.*

SICREE, ALBERT J., instructor in mechanical engineering, Stevens Institute of Technology, *Hoboken, N. J.*

SLATER, R. E., works manager, Bryan Harvester Co., Inc., *Peru, Ind.*

SMITH, FRED C., National director Y. M. C. A. automotive schools, United Y. M. C. A. Schools, *New York City.*

WALES, FRED A., sales engineer, Aluminum Co. of America, *Detroit.*